

Factors Affecting the Selection of Building Project Price Forecasting Tools

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List of Interviewees

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Brenchley Project Consulting	London	Lawrence Brenchley	Sole principal
Bucknall Austin Plc	Manchester	Paul Harper	Regional director
Bucknall Austin Plc	Birmingham	Mark Grozier	Team leader
Building Design Partnership	Manchester	Peter Smethurst	Associate director
Building Performance Group	London	Richard Allard	Associate partner
C E Ball & Partners	London	Andrew Hudson	Partner
Currie and Brown	St Albans	David Weight	Head of research
Davis Langdon & Everest	Chester	Mike Sutton	Quantity surveyor
E C Harris	London	Paul Moore	Head of research
Edmund Shipway & Partners	Manchester	David Hirst	Partner
Faithful & Gould	Bristol	Ian Donaldson	Director
Faithful & Gould	Leeds	Martyn Swift	Associate partner
Gleeds	Nottingham	James Fish	Associate partner
Godfrey Faux & Associates	Cambridge	Harvey Cooke	Quantity surveyor
James Nesbitt & Partners	Southampton	Neil McMullen	Associate partner
Needlemans	Saffron Waldon	Barry Trebes	Director
Nigel Rose & Partners	London	Terry Corderoy	Partner
Nigel Rose & Partners	London	Martin Hill	Quantity surveyor
Northcrofts	London	Stephen Smith	Head of research
Pheasant Keelagher Ptnrship	Warrington	Tim Keelagher	Partner
Philip Windsor & Associates	Chandlers Ford	Philip Windsor	Sole principal
PHJ Flood & Associates	Cheltenham	Peter Flood	Sole principal
Keith Miller & Associates	Ellesmere Port	Brian Kinnear	Partner
Robert Jackson & Partners	Southampton	Robert Jackson	Partner
Stephen Davis Associates	Manchester	Ivan Bradley	Partner
Symonds	Birmingham	Paul Brownsword	Associate partner
Turner and Townsend	Manchester	Rob Wood	Head of research
Tweeds	Liverpool	Mike Evans	Partner
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Abstract

Factors Affecting the Selection of Building Project Price Forecasting Tools

This thesis contributes to what is known about the investigation and formulation phases of the building project price forecasting advice process. The research has developed a greater understanding of what general factors affect the selection of non-traditional types of building project price forecasting models.

The thesis adopted a two-phased combined research approach. The first phase required a population mailed survey to be executed with over two thousand three hundred quantity surveying organisations located across England in 1997. The second phase required thirty-one in-depth interviews to be executed, with informed practitioners, in five rounds of data collection.

Consequently, this research firstly, established the types of building project price forecasting models or tools in-use in England. The study found that the called for paradigm shift away from the traditional types of models, had not yet been generally achieved. The study provided evidence that some types of quantity surveying organisations were moving towards the adoption of the non-traditional models, for use as additional tools. The study then, secondly, identified a number of general factors that were found to affect the selection of non-traditional types of building project price forecasting models.

The thesis concluded by generating a grounded constraints-based theory of factors found to affect the selection of non-traditional types of building project price forecasting models. The emergent theory identified the parameters needed to enable all types of quantity surveying organisations to become involved with the selection of non-traditional models or tools.

Glossary of Terms

For the purposes of this thesis the following meanings have been applied to the terms listed below :

Ethnomethodology	A general approach to research in which a subjects actions are analysed in order to gain an understanding of their thoughts and reasonings and then locating them on the cognitive map of the culture or process under investigation
Forecasting	The prediction of events or activities in the future which are subject to risk and uncertainty
Models	A framework that attempts to represent an observable complex system system or phenomenon which exists in the real world
Forecasting Tools	The techniques used by practitioners to formulate a building project price forecast
Grounded theory	A research strategy which seeks to identify sets of relationships which are inductively derived from the study of the phenomenon under investigation which has been discovered, developed, and provisionally verified through the systematic collection and analysis of data from the field that pertained to that problem
Paradigm	An approach or way of undertaking tasks or activities which is in common use or is generally available
Verstehen	A view of events, actions, norms, and values from the perspective of the people involved in the process

Chapter 1

INTRODUCTION

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Chapter 1

INTRODUCTION

1.1. Background

Clients considering the procurement of building works as sustainable solutions to their accommodation needs are involved in taking decisions on how best to use their scarce resources. Such clients are often provided with strategic advice in order to help them assess the anticipated value-for-money of differing solutions to their problems. For many clients, the advice that is related to their potential building project's construction price forecast is a key element in the evaluation of how best to use their scarce resources. Often the most critical of the advice related to initial building project prices relies on forecasts that are made on the basis of very little project-related design information. In such circumstances, the establishment of good quality advice is crucial to clients in their overall assessment of particular value-for-money business options.

Problems related to poor performance in the United Kingdom's (U.K.) construction industry have been the subject of frequent government investigations since the second world war. The Latham Report (1994) and now, latterly, the Egan Report (1998) are two of the most recent government publications calling for action to enhance the construction industry's performance. Amongst the issues highlighted for action in the more recent reports was the need to find improvements in the processes used by the industry to achieve better efficiency, productivity, and quality of output. Egan (1998, ch. 4, p.1) identified that such changes can best be '*affected by first sorting out the culture and then defining and improving the processes*' involved in the activity under investigation. Detailed research on *culture* is not considered in this work albeit that it must be interrelated to any *processes* being investigated. Accordingly, this work has been focused on the *processes* involved in the compilation of building project price advice for clients. A greater understanding of how good quality building project price forecasts have been formulated will contribute to construction industry clients making better quality business decisions.

Practical problems related to poor quality output, time, and cost over-runs on building projects as well as government reports calling for action have often been the stimuli for academic research in the field of construction management. This study, which commenced in 1994, sought to address one of the problematic themes indicated in the Latham Report (1994, p.14), namely, the need to provide good quality early stage building project price advice for clients. In particular, the work sought to investigate the processes by which such price forecasts were produced. It was also recognised that a greater understanding of the processes involved in the production of good quality building project price advice would help solve real practical problems faced by construction professionals active in the field.

The financial support given to the later stages of the work by the Royal Institution of Chartered Surveyors (RICS), which is the leading national and international professional body associated with building project price forecasters, indicated the relevance of the study to the problems faced by construction professionals in the field.

1.2 Aims and objectives

Aims

This research was designed to contribute to the development of good quality building project price advice provision for clients. In general terms, the research aimed to develop a greater understanding of how the factors that affected the selection of non-traditional types of building project price forecasting models influenced practitioners who were involved in the process of building project price forecast investigation and formulation. This was achieved by investigating what types of models were in actual use and how and why construction professionals in the field selected particular types of building project price forecasting model(s) for use.

Objectives

The principal objectives of the study were to,

- (1) Identify the building project price forecasting models in use in England in order to identify the nature of any paradigm shift towards the newer non-

traditional types of building project price forecasting models, as had been predicted by Brandon (1982).

- (2) Identify the organisational types, sizes, and location of quantity surveying organisations that were more likely to be involved in using the newer non-traditional types of building project price forecasting models
- (3) Identify factors that affect the selection of building project price forecasting models and establish which of them could be considered as being more influential.
- (4) Develop an understanding of how the factors that affect the selection of non-traditional types of building project price forecasting models in general impact upon the model selection processes of construction professionals situated in differing organisational settings
- (5) Develop a grounded theory of the factors found to affect the selection of non-traditional types of building project price forecasting models.

1.3 Hypotheses and propositions

Given the broad aims and specific objectives set out for the study, the initial hypotheses and propositions for the study, when it commenced in September 1994, were,

- (a) The paradigm shift towards the newer non-traditional types of building project price forecasting models called for by Brandon (1982) has not yet been generally adopted by construction professionals involved in the investigative and formulative phases of the building project price forecasting process.
- (b) Organisations located in the north of England would have a lower incidence in-use of newer non-traditional types of building project price forecasting models than organisations that were located in the south of England (including London).
- (c) There would be no difference in the incidence in-use of non-traditional types of models selected for use between quantity surveying organisations of different types and sizes.

- (d) Lack of model understanding would be the major reason why quantity surveying organisations were less likely to use the newer non-traditional types of building project price forecasting models
- (e) Practitioner perceptions related to lack of model output accuracy of the newer non-traditional types of building project price forecasting models would be the main factor used by practitioners to discriminate between different types of models in-use.
- (f) The selection of particular types of building project price forecasting models was affected by the inter-relationship between factors related to a business unit's organisation, operation, location, and factors related to the forecast model, the forecast preparer and the forecast user.

1.4 Relevance of the work

This study was concerned with the provision of building project price forecasting services to clients of the U.K. construction industry. The provision of such services can be the responsibility of a number of different construction professionals located in a variety of different types of business settings. For instance, building project price forecasts can be provided by consultant designers, consultant quantity surveyors, or staff employed within building contracting organisations engaged to undertake the projects. Conventionally, in England, it is the responsibility of the clients' consultant quantity surveyors to provide any necessary building project price forecasting advice. Access to mailing lists of consultant quantity surveying organisations was restricted to those organisations that were operating in England in 1997. Therefore, this study has been limited to investigating the building project price forecasting model selection process amongst that group of construction professionals.

Bowen and Edwards (1996, p.400) identified that the provision of building project price advice was '*a basic service... the raison d'être*' of quantity surveyors involved in the assessment of value for money in building project designs. The provision of such advice was cited by Male (1990, p.193) as one of the truly 'professional' services quantity surveyors provided to their clients.

Previous work also established that the provision of building project price forecasting advice could be thought of in terms of distinct phases of a complete process. Prior work, notably by Bowen (1995), developed a communications-based theory of building project price advice that divided the process into two stages. Firstly, the forecast formulation stage and secondly, the forecast transmission stage. Given that division, this study was restricted to examining the process by which building project price forecasting advice was *formulated for clients by their consultant quantity surveyors*.

Clients can receive building project price forecasting advice from such practitioners who can be located in a variety of business organisational situations. Accordingly, the study investigated the building project price forecasting model selection process adopted by consultant quantity surveyors, working within organisations of different types, sizes and geographical locations. The organisations studied styled themselves as being either *consultant chartered quantity surveyors; or consultant project managers; or multi-disciplinary project consultants*.

All the business organisations that participated in the study were listed in 1997 by the RICS as being organisations based in England where chartered quantity surveyors were employed, and in which it was likely that a building project price advice service was provided to clients.

1.5 Research Design

The determination of an appropriate research design for any study needs to take account of several factors, namely, the prevailing research approach in the discipline in which the study is situated, the nature of the research problem(s), the scope of the work, and the availability of resources such as time, support staff, and finance.

Construction management, as a separate academic discipline does not have the long established traditions and conventions in terms of its research paradigms, that disciplines within the natural sciences or general arts and humanities fields have. Academics such as Harriss (1998) even doubt that construction management could be considered to be a separate academic discipline in its own right. Harriss (1998,p.100) argued that as

construction management is made up of '*several different disciplines*' such as economics, management, and psychology, and as each discipline has its own research methods then construction management should adhere to the scientific methods that have been followed in each of its constituent parts. In such well defined academic fields as economics, management, and psychology the prevailing research paradigms have been clearly established. In the natural sciences the research methodology adopted conventionally reflects a positivist or scientific approach whereas in the arts and humanities field the approach most often adopted reflects an interpretivist or humanist methodology.

This study asserts that construction management as an academic discipline may be thought of as being positioned between the philosophies prevalent in the natural sciences and in the arts and humanities. In some respects construction management, as an academic discipline, may be categorised as being similar in its positioning to the social sciences, in which case the prevailing research paradigm can be said to be pluralistic in nature. In the social sciences the research designs adopted tend to reflect the nature and circumstances of the problems under investigation. However, such a balanced approach within the construction management field has not yet been widely accepted. This situation was illustrated by Seymour and Rooke (1997) who found that the majority of published research within the discipline's leading academic journal, namely, *Construction Management and Economics*, adopted a quantitative approach to research design.

Quantitative research designs are most often associated with a positivist or scientific research philosophy. Seymour and Rooke (1997) made a call for a debate on the nature of the research paradigm to be adopted in construction management. In so doing they made a strong case for research in construction management to move away from its current quasi-scientific approach and adopt an interpretivist approach that would better suit the investigation of people, their practices, and their processes. Runeson (1997) and Harriss (1998) made equally strong pleas for research in construction management to adhere to the centrality of scientific methods of inquiry in its approach to knowledge acquisition and theory development.

Raftery *et al* (1997) argued strongly for a multi-method paradigm that reflected the pluralist approach found within the social sciences. Harriss (1998, p.114) was particularly scathing about the potential for ethnomethodology to generate any generalisable theories and he dismissed the interpretivist approach as '*an orgy of subjectivism*'. Chau *et al* (1998) made a plea not to '*throw the baby out with the bath water*' by abandoning the practice and principles of scientific method when they reinforced the case for a more balanced or 'pluralist' approach to be adopted in construction management research.

Given the on-going debate over the appropriateness of particular research paradigms within the academic field of construction management it was resolved to determine the approach that was adopted within this study by taking account of the actual research problems under consideration. This was the approach advocated by Chau *et al* (1998, p99) who suggested that, since construction management was a practical subject, the choice of research approach should equally be a 'pragmatic one'. It was clear that the aims, objectives, and hypotheses set out above called for research questions that related to 'what' and 'how many' as well as 'how' and 'why'. Research problems related to 'what' types of building project price forecasting models were in use, their incidence of use, and the organisational, locational, and operational factors suspected as affecting 'how many' times they were used could best be answered by the adoption of a quantitative research design. Given such an approach it was resolved to collect data via a postal questionnaire survey of current practices in practitioner organisations.

The development of an understanding of 'how' and 'why' differing criteria affected the selection of particular types of models by practitioners required much more deeper, richer data to be gathered and analysed. This type of research problem called for a qualitative approach to be adopted in which the data were collected via in-depth conversations with a number of informed construction professionals in the field.

Therefore it was resolved to adopt a pluralist research approach for this study as advocated by Raftery *et al* (1997) and Chau (1998). This approach sought to match the particular research design to the particular research problem(s) under investigation. This approach was facilitated by the financial contribution made by the RICS. Their

contribution paid the travel costs incurred during the execution of the qualitative phase of the study. This latter phase of the study required a number of in-depth conversations with practitioners situated in organisations of differing types, sizes, and geographical locations in England.

1.6 Structure of the thesis

This thesis was structured to reflect the process that was followed to resolve the research questions indicated above. The steps along the way have been illustrated in Fig. 1.1 The main steps included, identifying the research issues and problems, settling an appropriate research design, collecting and analysing both quantitative and qualitative data, determining findings, and considering their implications for both academe and practice.

The work was executed in distinct phases,

* **Section 1**

established the background to the study by examining building project price forecasting theory.

* **Section 2**

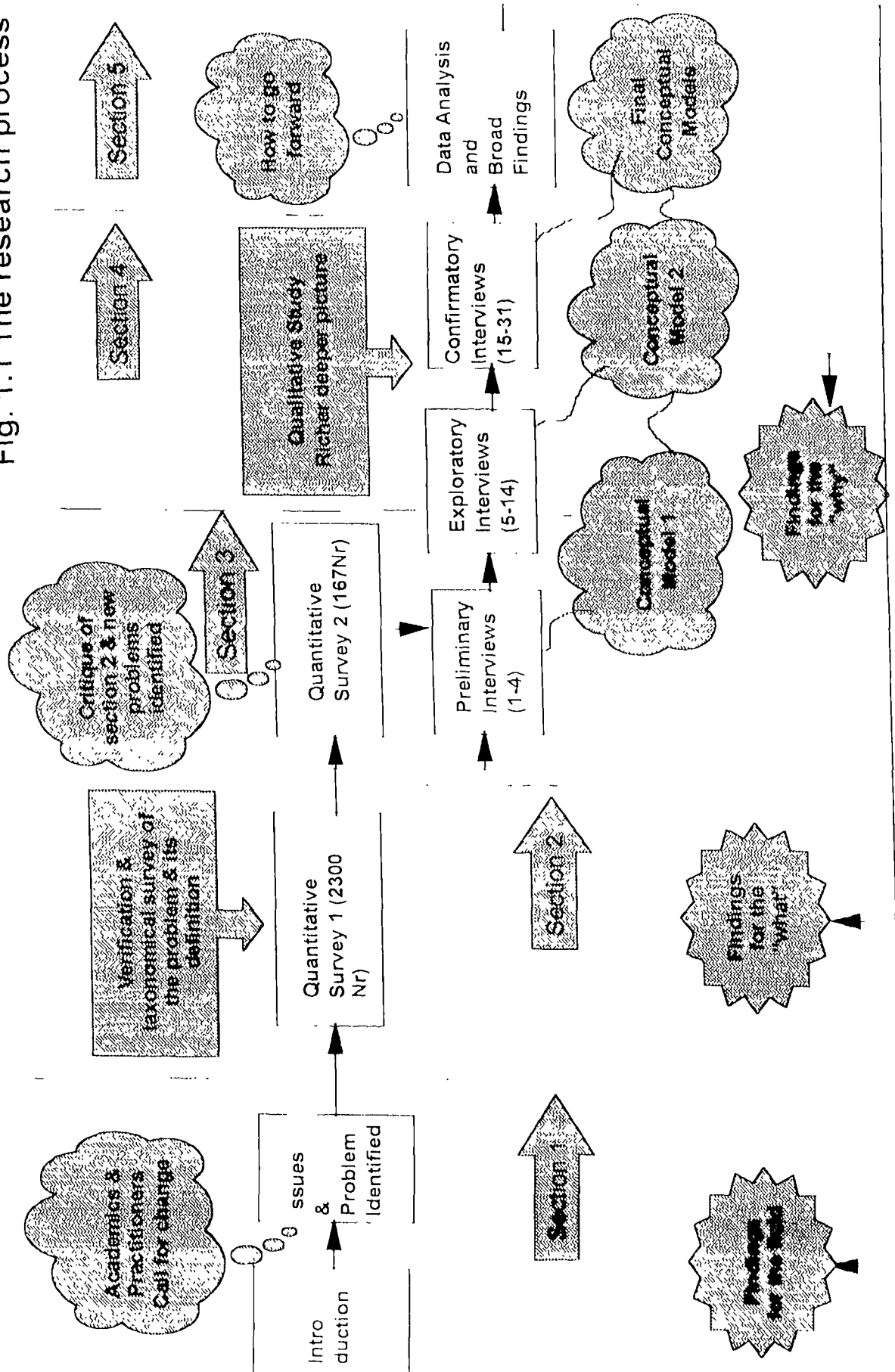
mapped out the current state of the art in building project price forecasting practice. This was achieved following the execution of a quantitative investigation of the types of building project price advice models available and in-use. This investigation was conducted via a nationwide survey which was undertaken amongst all two thousand three hundred and twenty-seven quantity surveying organisations that were listed by the RICS as operating in England in 1997.

The results of the survey provided data which addressed objectives (1) and (2) of the study which were set out above

* **Section 3**

explored the territory of factors thought to affect the selection of the types of building project price forecasting models that were found to be in-use. The study examined appropriate methods to elicit such knowledge from construction professionals in the field. This process was facilitated

Fig. 1.1 The research process



via a qualitative investigation that sought to reveal a richer, deeper picture of the factors that caused practitioners to choose particular types of building project price forecasting models for use.

The data generated addressed objectives (3) and 4) of the study which were set out above

- * **Section 4**
developed conceptual models and propositions that sought to capture the dynamic between conflicting selection factors found within distinct organisational settings. The propositional models developed addressed objective (5) of the study which was set out above, and facilitated the emergence of a grounded constraints-based theory of factors affecting the selection of non-traditional types of building project price forecasting models which could be used as the basis of further studies in the field
- * **Section 5**
brought together the main findings of the work, sets out its implications for academics and practitioners, identifies its limitations, and directions for further work in the area.

The thesis consists of ten chapters which reflect the process indicated above. Each chapter is briefly summarised below,

Section 1

- Chapter 2 Identifies the central issues and problems that were addressed in the body of the thesis. It reviews literature on general business forecasting as well as subject specific literature related to building project price forecasting, the types of models suspected as being in use, and the case for change called for by academics.

Section 2

- Chapter 3 Provides a rationale for the research methodology adopted and details the development, piloting, distribution, and general results of a nationwide

postal survey (sample size 2327) amongst quantity surveying organisations based in England in 1997.

- Chapter 4 Analyses the data gathered in chapter 3 using the minitab 10 statistical package and discusses the implications of the findings in terms of the aims and objectives of the study, and identified further unresolved research questions.

Section 3

- Chapter 5 Reviews subject specific and general business literature in order to identify the factors suspected as affecting the selection of different types of building project price forecasting models. The factors identified were then confirmed as being relevant by a limited quantitative study (sample size 167) with construction professionals in the field. The chapter then acts as a fulcrum for the study as it makes the case for further work to be undertaken to investigate how and why the factors identified as affecting the model selection process impact on practitioners situated in differing organisational settings
- Chapter 6 Reports an initial round of preliminary interviews (4) conducted with construction professionals in the field in order to confirm the findings from the postal survey previously detailed. It also details the generation of an initial outline conceptual model that bounded the collection of further qualitative data.

Section 4

- Chapter 7 Details the selection of participants (10) and the collection and analysis of further qualitative data on issues affecting the selection of building project price forecasting models for use by construction professionals in the field. The qualitative data gathered were analysed using the nud*ist4 software package. It also details the development of propositional models grounded in practitioner experience in order to shape the collection of additional data in the field. The chapter identifies the emergence of a constraints-based theory of factors affecting model selection
- Chapter 8 Details the selection of further participants (17) and the collection and analysis of qualitative data that grounded the factors found to affect the selection of different types of building project price forecasting models for

use by construction professionals in the field. The chapter also details the development of an emergent grounded constraints-based theory of building project price forecasting model selection.

Section 5

- Chapter 9 Discusses the issues emerging from the results of the study in terms of the the findings identified from the quantitative and qualitative investigations carried out in sections 2, 3, and 4 of the thesis, and the issues and gaps in theory and practice that were identified in section 1. The chapter considers the wider implications of the results of the study for academics and practitioners in the field.
- Chapter 10 Concludes the thesis by indicating the main findings of the work. The chapter also includes a reflective section that indicates the limitations of the study and provides recommendations for further work on the topic.

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CHAPTER 2

LITERATURE REVIEW AND RESEARCH PROBLEM IDENTIFICATION

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CHAPTER 2

LITERATURE REVIEW AND RESEARCH PROBLEM IDENTIFICATION

2.1 Introduction

2.1.1. Generally

This chapter sets out the relevance of the study in terms of its significance to construction industry professionals, their clients, and other academics in the field. Firstly, it defines the key terms and concepts related to the topic and then it reviews previously published material in order to identify key contributions that have defined the state of knowledge and past research agenda on the topic. This review and critical analysis enables the work to focus on research questions related to the enhancement of quality in building project price forecasting. Such a focus for the work ensured that the results of the study have contributed to the knowledge already established in relation to the topic.

The chapter sets out the context for the work by mapping out a picture or model of the building project price forecasting process and then locating the study in relation to other work within the area. The chapter develops an updated taxonomy of building project price forecasting models alleged by academics to be available for use by practitioners in the field. The available classification systems were evaluated in order to assist in the development of an updated typology which facilitates the development of an appropriate research design for the resolution of the problems identified.

Some of the words or terms used within this section of the thesis can have more than one meaning for professionals and academics in the field. It was resolved to make clear the meanings this thesis attached to these terms at this early stage.

2.1.2. Definition of common terms

(i) Estimating and / or forecasting

The concise Oxford dictionary defines estimating amongst other things as '*an approximate judgement, number or amount, ... a contractors statement of a sum of money for which specified work will be undertaken*'. The same dictionary offered the following definition of forecasting as being '*a foresight or conjectural estimate of something scheduled to happen in the future*'. In relation to the construction industry and its academic community it appears that the two words have often been used for the same thing. For instance, text books such as those by Ashworth (1991), Ferry and Brandon (1994), and Morton and Jaggar (1995) have made no distinction between 'estimating' and 'forecasting' in their discussions on building project price forecasting. Similarly, codes of practice distributed by the RICS and the Chartered Institute of Building (CIOB), which are the two professional bodies most closely associated with building project price forecasters, have used the term 'cost estimating' when they were referring to 'price forecasting'.

Following reflection on the dictionary definitions offered above it seemed that a subtle difference did exist between the words '*forecast*' and '*estimate*' in the context of the construction industry. The word '*forecast*' implies the reflection of more uncertain future events or activities than the word '*estimate*'. The word '*estimate*' implies a more robust ascertainment of future events or activities.

In terms of this thesis it was resolved to use the word '*forecast*' when it was referring to the prediction of events or activities in the future due to the inherent presence of uncertainty in the design and construction process. When issues have been illustrated with quotations from previous research and the context of that research has indicated that the more appropriate word to use would have been '*forecast*' rather than the word '*estimate*', which was the actual word used, then notwithstanding the above, the acknowledged quotation has been faithfully reproduced.

(ii) **Modelling**

The concise Oxford dictionary defined modelling as being '*a representation of a proposed structure in a number of dimensions*'. Raftery (1984, p.55) in his PhD study on the sensitivity of cost models to their data sources indicated that modelling in terms of decision analysis could be considered to be

'a representation of reality made sufficiently explicit for one to be able to examine the assumptions embodied within it, to manipulate it, experiment with it and most important of all to draw inferences from it which can be applied to reality'

Ashworth (1986, p.1) maintained that the aim of models was to '*portray accurately the cost variable relationship of a design so that improved cost estimating or design optimisation could result*'. Newton (1991, p.98) asserted that a model could be used to '*represent or describe features of interest in a system and how those features might interact*'. Ferry and Brandon (1994, p.104) described models as being '*representations of real situations in another form, or to a smaller scale, so that a realistic appraisal of performance can be made*'. Raftery (1998, p.296) asserted that a model was a '*connotation or representation, for purposes of display or analysis of some observable system or phenomenon which exists in the real world*'.

Modelling is thus assumed to be generally accepted as being a framework that attempts to represent an observable complex system or phenomenon which exists in the real world. Raftery (1984, p.60) indicated that '*modelling allowed complex activities which were often shrouded in mystique to be represented in a form that facilitated display, understanding or analysis*'. Thus it can be seen that it is not possible for a model to present a completed framework of an observable system.

In terms of this thesis, the word model has been used on an interchangeable basis to describe the techniques or tools employed by relevant construction professionals when seeking to represent the total monetary consequences of the design decisions of others on the prices that their clients were likely to be charged by contractors, for the assembly of the necessary resources, and the organisation of the physical construction of the potential building projects.

(iii) **Cost modelling and / or price modelling**

Established textbooks such as those by Ashworth (1991), Ferry and Brandon (1994), and Morton and Jaggar (1996) have referred to the tools used by forecasters to prepare their forecasts as both '*models*' and '*techniques*'. Newton (1991) drew a distinction between the two terms and used the word '*technique*' to describe an individual tool or mechanism used to formulate building project price forecasts and the word '*model*' to describe a grouping of techniques with similar characteristics. In this thesis it has been resolved to adopt Newton's definition and use the word '*model*' to describe a grouping of forecasting techniques with similar characteristics and the word '*technique*' or '*tool*' when referring to an individual forecasting mechanism.

Ashworth (1986, p.1) in his paper on the history and development of cost models indicated that the term cost modelling could be used to describe

'the constructor's model, which was an attempt to forecast the constructors costs as well as the designers model which is a prediction of the constructors model and which is prepared some time in advance of it'.

It would seem that Ashworth's distinction between the terms has not been widely adopted by either practitioners or by past researchers in the field as the term "*cost modelling*" has been widely adopted, incorrectly, as the term that has covered both the constructors and designers domain. For instance, cost modelling has been defined in general terms in textbooks such as Ferry and Brandon (1994, p.105) as being,

'a symbolic representation of some observable system which exists or is proposed and which is represented in terms of its significant cost features for the purposes of display, analysis, comparison or control'.

Raftery (1998, p.300) asserted that practitioners as well as academics were prone to using the term incorrectly. Raftery indicated that

'quantity surveyors frequently refer to cost estimating when they were, in fact, referring to their estimations of probable project bid prices which were being made while the building was being designed and long before any contractors became involved'.

Raftery (1998) saw a clear distinction between the terms '*cost modelling*' and '*price modelling*'. In particular Raftery (1998, p.301) defined '*price modelling*' as

'the figure which represents the contractors market price for carrying out a particular project, which was itself predicted by consultants involved in attempting to forecast that market price during a project's design phase in order to assist a client in the management of a projects finances'.

In addition the term '*price modelling*' can also be applied to the consideration of the economic models used to determine national and/or regional tendered costs for constructing building projects. For instance, papers by Taylor and Bowen (1987), Rawlinson and Raftery (1997), Ching *et al* (1998), and Akintoye *et al* (1998) addressed aspects of price modelling performance in terms of the assessment of industry wide trends, relationships, and predictions in construction costs.

Given the above it has been resolved to draw a clear distinction between the differing domains represented by the terms of cost (contractors domain) and price (individual clients and industry wide domain) modelling. In terms of this thesis the general term '*price modelling*' and the specific term '*building project price forecasting*' have been adopted throughout the thesis. It was decided that price modelling was the more appropriate general term to use as the work has concentrated on models that represented the total price that individual clients have had to pay constructors for undertaking their proposed building projects. This work has **not** addressed matters related to the modelling of economic trends or forecasts on an industry wide basis.

In this respect the definition adopted in this thesis has followed Raftery's (1984,p.55) lead by deciding to define '*price modelling*' as being '*a representation of the market prices or tender levels for building projects that takes market forces into account as well as constructors costs*'. Raftery (1984, p.112) also asserted that price models could be considered to be '*macro or micro in nature*'. This assertion implied that price models could be used to predict the total (*macro*) monetary price that clients were likely to pay for the construction of their proposed building designs. In addition, the term '*price models*' could also be used to provide designers as well as clients with an evaluation of the monetary consequences of differing design decisions related to part (*micro*) of the total design. In terms of this thesis it was intended to consider building project price forecasting models that were capable of providing project related information on both a '*macro*' and a '*micro*' level to designers and clients.

When issues have been illustrated with quotations from previous research and the context of that research has indicated that the more appropriate general term to use

would have been '*price modelling*' rather than the term '*cost modelling*' which was the term actually used, then notwithstanding the above, the acknowledged quotation has been faithfully reproduced.

2.2 Context for the work

A regular feature of the construction industry has been the need for its prospective clients to be advised of their likely financial commitment prior to their commissioning of expensive project design work. The relevance and importance of this advice for clients has been reported over many years by academics, such as Southwell (1971) who said,

'The need for prospective building owners to be informed of their likely financial commitment prior to the commissioning of extensive design work together with the disproportionate commitment to expenditure by early design decisions underlines the importance of estimates in the very early stages of a building project'. - (1971, p.23)

and Skitmore (1983, Q4, p.3) who commented,

'it is important, in the modern construction industry, for prospective building owners to be informed of their likely financial commitment in purchasing new construction prior to commissioning expensive design work'

Tababai *et al* (1997, p.271), indicated that clients of today still have a need for such building project price advice when they said,

'Construction projects are susceptible to cost and time overruns. Variations fromplanned cost estimates can result in huge losses for owners....in extreme cases, the viability of the project itself can be jeopardised as a result of variations from baseline plans'

The significance of building project price forecasting to clients has also been highlighted in standard textbooks on the subject, such as those by Ferry and Brandon (1991, p.3), which stated that

'From the earliest of times people have needed some idea of what a new building was going to cost before they started work on it, "Would any of you think of building a tower without first sitting down and calculating the cost, to see whether he could afford to finish it, - St Luke, Ch.14"'

and again '*it was therefore important that the client should have a good idea of what the building is likely to cost before he had committed his resources very far*', (1991,p.4).

Ashworth (1994, p.1) identified that '*one of the clients main requirements in respect of any construction project was the assessment of its expected cost*'. The importance of a building projects price forecast was also highlighted in Morton and Jaggar's (1995, p.34) text who also commented on what clients were currently experiencing in terms of performance,

'to people outside the industry and particularly to alarmed clients, the unpredictability of building costs is a puzzle.....before the commissioning of a new building the degree of uncertainty about the price can seem astonishing.....yet in spite of the amount of cost information available and a profession skilled in its analysis there still seems to be serious problems in assessing and predicting the costs of buildings'

More recently government reports, such as those by Latham (1994) and Egan (1998) on the failings of the construction industry have, amongst other matters, brought the problem of setting reliable initial budgets for proposed building projects, against which value for money could be assessed, back into focus. They have also highlighted the significance of the provision of reliable strategic building project price advice in terms of it being a pre-requisite to the ability of clients to make the best use of their own and society's scarce resources. The significance of the problem, from the construction clients point of view, was demonstrated by Latham (1994, p.3) when he said that, *'clients were at the core of the process and their needs must be met by the industry.... in order to obtain better value for money'*, and Egan (1998, ch.2, p.1) who commented, in relation to the under achievement in the industry, that, *'more than one third of major clients were dissatisfied with their consultantsin providing value for money'*.

Such strategic construction price advice has now been commonly accepted as one of the key factors considered by clients in their decisions on whether to proceed with proposed building projects. Conventionally, the responsibility for the provision of this advice has lay with clients' cost consultants who, in England, are known as quantity surveyors. It has been pointed out by Ashworth (1986, p.1) that this activity is *'....central to the practitioners expertise'*. Newton (1991, p.108) also pointed out that the provision of such strategic construction price advice could be considered as a truly professional activity because in the world of construction, *'costs of potential building projects are neither clearly defined nor precise rather they form a misty world of complexity'*.

Male (1990) in his doctoral work on professionalism in quantity surveying picked up on the theme of complexity and asserted that the provision of strategic construction cost advice was of importance to quantity surveyors in that it was an activity that was *'.... central to the claims of quantity surveying to be considered as a profession'*. This was because the formulation and transmission of this strategic financial advice was usually carried out in

circumstances of *'great uncertainty, where expertise and judgement needed to be exercised'*, (1990, p.193). The significance of this building project price forecasting service to clients was also highlighted by Akintoye *et al* (1992, p.107), when they said, *'the communication of cost information to the client to ensure efficient design, realistic pricing and production of a building was a fundamental aspect of the quantity surveying profession'*.

Raftery (1984, p.60) referred to the process of cost estimating in the construction industry as being an activity that was *'shrouded in mystique'*. This has often been a characteristic of activities widely seen as being professional in their nature by society at large. The provision of reliable building project price advice in such circumstances was central to Male's (1990, p.200) claim that quantity surveying could be considered as a profession. Male asserted that advice provided in such circumstances was similar to that *'... most often associated with a truly professional activity'*.

In England the difficulties of providing this professional price advice at the early stages of a building project have often been exacerbated by the very nature of its construction industry. For instance, it has been common to find that the designers and constructors for particular building projects were very often not in the same organisational setting and were very often positioned on differing sides of a contractual divide. This was commented upon by Wilson (1984, p.61) when he pointed out that,

'....as design takes place well before construction so the economic modelling of the impact of design decisions involves forecasting the future economic situation - which is a notoriously difficult task' .

Thus the actual setting of the advice providers and the complexity of the task itself add to the uncertainties of the building project price advice process and the frailty of its consequent output.

Given the above circumstances there can be little surprise that there still exists a popular perception amongst clients, academics and other design professionals that the provision of early strategic financial advice by quantity surveyors has often been of poor quality. Ashworth (1986, p.2) commented that the need for new cost models *'arose in response to the poor performance of existing cost forecasting methods'*. This feeling was explored and found to be prevalent in the empirical studies on clients attitudes that collected evidence on an

international basis by Proctor *et al* (1993). Ellis and Turner (1986, p.11) showed that the areas of highest client dissatisfaction with the services of quantity surveyors was '*initial cost advice before the production of drawn design information*'. Morton and Jaggard (1995, p.34) in their textbook summarised the feelings of many clients when they said,

'...yet in spite of the amount of cost information available and a profession skilled in its analysis there still seems to be serious problems in assessing and predicting the costs of buildings'

In England there has been a paucity of explicit data available to examine the veracity of the perceptions reported above. Indeed, in an empirical study undertaken by Grieg (1981) with thirty quantity surveying practices in Edinburgh, Scotland the opposite results were found. That study revealed that '*clients were well satisfied with the cost advice received on their projects*'. However, the presence of bias due to the location, size, and nature of the participants in the study mean that the results of that work could not be taken as applying generally to the situation in England.

More recently, other empirical work on the attitudes of clients reported by Dawood and Bates (1998), as well as Elhag and Boussabaine (1998) have pointed to continued client discontent with the price forecast advice provided to them by their consultant quantity surveyors. So the common perception of dissatisfaction with quantity surveyors' building project price forecasts remains. Such perceptions have no doubt been fueled by the often biased reporting in the media of large scale construction projects, such as the infamous Thames Barrier project and the Sydney Opera House project which were originally forecast to cost £23 and £2.5 million and finally cost £461 and £87 million respectively. More recent projects such as the channel tunnel and the new British library, have also reported final costs way in excess of their original price forecasts.

Academics have long expressed dissatisfaction with the standard of building project price forecasting undertaken by quantity surveyors in practice. This dissatisfaction must in part be caused by the nature of the advice itself. In providing this service for clients it has been necessary for quantity surveyors to predict future uncertain events. Such predictions were in fact forecasts of prices to be charged by contractors to clients for the construction of their building projects. For instance, Ogulana and Thorpe (1987, p.44) argued that '*measured in-*

place quantities models seem to have reached the limit of their development and are insufficient either for estimating (forecasting) or for cost (price) advice at the design stage’.

Other academics such as Fine (1982), had already indicated that it was apparent that the domineering presence of uncertainty in the construction process mitigated against the production of accurate estimates of costs by the conventional techniques of numerical analysis and synthesis alone. Ashworth (1986, p.5) reflected that the

‘poor quality and reliability of current cost forecasting practice in the construction industry has caused some surveyors - both practitioners and academics to look beyond the traditional methods available’.

Such perceptions were due to the fact that price forecasts must include not only estimates of contractors own estimates of the resource costs that were likely to be incurred in the execution of the projects, but also predictions or judgements of the likely market forces that would be prevailing at the time the contractors bid for the work.

Seminal works by Brandon (1982) and Bowen and Edwards (1987) reported dissatisfaction amongst academics with the way practitioners persisted in approaching the provision of building project price advice. They called for a *‘paradigm shift’* away from the utilisation of conventional single point deterministic forecasting models that were asserted as being incapable of reflecting the uncertainty and risks inherent in the building production process. Both Brandon (1982) and Bowen and Edwards (1987) claimed that such a shift towards newer computerised stochastic models would ensure that better quality forecasts were provided to clients who were considering differing value-for-money solutions to their business problems.

More recently Bowen and Edwards (1998, p.16) identified that the process of how building project price forecasts were produced needed to be investigated as well as the relevance and quality of the actual forecast produced, when they said, in their review of models in-use in South Africa, that *‘it was important that the investigative process of cost planning (building project price forecasting - see glossary of terms) not only used appropriate data but also used the most appropriate techniques.....’.*

This section has set out the context of this proposed study in national and international terms. It has demonstrated that the provision of building project price forecasts continues to be a real world service that is needed by clients of the construction industry, as well as society at large, in order for their scarce economic resources to be put to best use. It has been indicated that in England the responsibility for the provision of such building project price forecasts lies with clients' consultant quantity surveyors. Evidence provided has indicated that there was dissatisfaction with the way in which building project price was being produced. Given this context it has become apparent that the focus of this study would enable a contribution to be made which would aid the resolution of real world problems if it examined what consultant quantity surveyors 'did' and 'how they went about doing it' in terms of the provision of building project price forecasting advice. It was decided that an inquiry on such lines would discover a 'quality' or 'best practice' approach that could then be made available for use by other practitioners in the field.

2.3 Building project price forecasting and its quality assessment

2.3.1 The process of building project price forecasting

The issues which need to be addressed in order to develop an understanding of how building project price advice may have its quality enhanced included the need to identify, firstly, the processes involved in its production and, secondly, to identify measures by which its quality could be enhanced. To understand these problems it was decided to develop a picture of the advice function which showed its constituent parts in the context of accepted theory.

The process of producing building project price advice was identified by Skitmore (1991, p.17) in his work on pre-tender design forecasts as being more than a technical calculation. He asserted that the *'dominating presence of uncertainty in the construction process mitigated against the production of accurate estimates by numerical analysis alone'*. Skitmore concluded that the process of building project price production must include the technical formulation or calculation of the advice and the application to it of the forecast

preparer's expertise or judgement. Al-Tabtabai and Diekmann (1992, p.274) confirmed that judgement was needed in the formulation and communication of strategic cost advice when they suggested that a good price forecasting technique needed to include both '*historical trend based data and competent "judgements" based on construction experience and knowledge*'.

Bowen and Edwards (1994) in their work on communications and the building project price forecasting process asserted that in its formulation there were intra-personal judgements made by practitioners on issues such as, price data and its relevance to project location and project complexity. This work allowed Bowen (1995, p.2) to offer a more detailed definition of the building project price forecasting process when he stated that it comprised,

'an investigative process and an interpersonal (input and output) process. The investigative process was concerned with the application of price modelling techniques to produce price forecasts. The interpersonal communication process was concerned with the communication of the input into and the derived information from the investigative process'

Given the above definition it can be seen that the process of building project price forecasting can be divided into a formulation phase and a communication phase. Fig 2.1 was developed by Fortune and Lees (1996) as part of their work on the use of judgement in the building project price advice process. It has illustrated the divide between price advice formulation and its communication to others. Fig. 2.1 also indicated that the advice function could be considered as containing both decisions and judgements. The diagram suggested that the building project price advice process could be best viewed as a series of decisions leading to a judgement.

The decisions centre around the building project price model and its operation. For instance they have often related to matters such as, which model to use, which data source to use, what information was available, and so on. These decisions involve the interaction between the technical models available and called on the forecast preparer involved with the formulation of the advice to finally decide on the selection and use of particular models in given project circumstances. This inter-action reflected the '*intra-personal communication process*' identified above in Bowen's (1995, p.2) definition. All of these decisions have to be made in the operation of the price model. Bowen

(1995, p.40) indicated that the '*selection and application of particular price models forms an integral part of the intra-personal communications process undertaken by consultant quantity surveyors*'. Bowen (1995, p.40) went on to provide a strong mandate for this study when he indicated that a communications-based examination of the actual practice of price forecasting and the provision of price advice needed to be undertaken in order to develop a model of the '*actual*' as opposed to the '*theoretical*' communications environment of the price forecasting process.

Fig 2.1 also shows that the building project price forecasting process involved judgements being made. Judgement involves the application of a cognitive process to the product of the decisions. Judgements are different from decisions in that the consequences of judgements do not have direct consequence on the makers of them. Practitioners are of course indirectly affected by the advice they have provided in that their future employment will depend upon the quality, or perceived quality, of the advice given. The practitioner will have made a number of decisions along the way, such as which forecasting model to use, but the building project price advice provided would be an assessment, a forecast and as such is a judgement. The judgement shown in Fig 2.1 is related to the inter-personal communication process identified by Bowen (1995) that occurs when the forecast provider informs the forecast purchaser of the likely monetary consequences of the proposed buildings design.

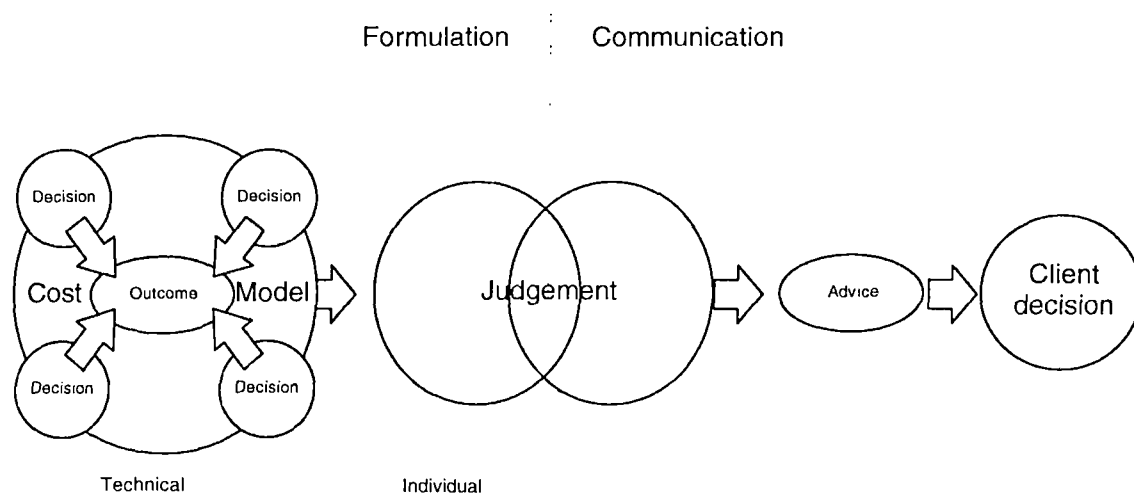


Fig. 2.1 -The building project price advice process

Bowen (1995) established that the human processes involved in the transmission of price advice to clients was affected by the inter-personal communication process itself and issues connected with judgement, (intrapersonal communication) such as bias, errors, and heuristics. Work on interpersonal communication processes and issues connected with judgment have been the subject of separate studies by Bowen and Edwards (1994), Raftery (1995), Birnie (1995), and Fortune and Lees (1997) and so they will **not** be included with within the scope of this work.

Thus Fig.2.1 shows a picture of the building project price advice process in terms of its formulation and transmission. The reception of the product of the process i.e. the actual building project price advice allows clients to make their business decisions in an informed manner. Such advice would in turn allow them to optimise their own and society's scarce resources. Good quality business decisions can only be helped by the receipt of good quality building project price advice. The development of an understanding of quality in terms of the formulation of building project price forecasting was seen as the first step along the way.

2.3.2. Quality in building project price forecasting

Quality building project price predictions, given the uncertainties and risks that are present in the construction industry development process, are ones that clients find reliable and robust enough for them to use as the basis of their value related assessments of differing business strategies. Makridakis *et al.* (1983) found that forecasts prepared and applied in general business were judged to be a success if good quality decisions were subsequently made regardless of the perceived level of accuracy achieved by the forecasting model selected.

However, the conventional assumption amongst practitioners and some academics in construction management has been that accuracy of model output was the single criterion by which 'good quality' early stage building project price advice for clients could be judged. Anecdotal evidence from practitioners based in England and empirical

evidence collected from quantity surveyors practicing in South Africa (Bowen, 1985) has shown that practitioners commonly perceive that their early stage construction price advice needed to be as close as possible, as soon as possible, to the lowest bid finally offered by contractors willing to undertake the building works.

Dictionary definitions of 'quality' refer to abstract notions of 'goodness' and degrees of 'excellence'. Early work related to the quality of building project price forecasts concentrated on considering 'goodness' or quality in terms of a single criterion, namely, accuracy of model output. This early work sought to establish reliability or robustness of advice by comparing the building project price forecasts given with actual tenders received

For instance, comparative studies by James (1954), McCaffer (1975) and Ross (1983) considered quality of building project price forecasting only in terms of the accuracy of the forecasts given as compared to the tender prices received using the m^3 , m^2 and storey enclosure methods (James), multiple regression methods (McCaffer), and different approximate quantities methods (Ross). Work by Morrison (1984), and Ogulana and Thorpe (1987), reported empirical studies on the accuracy of building project price forecasts and established norms in terms of percentage variances that could be achieved using conventional project price forecasting models.

Morrison (1984) assessed the performance of a range of building project price models in terms of their accuracy as compared to actual tenders received and concluded that the performance of the models reviewed was so poor that *'the conclusion must be that quantity surveyors' current systems of estimating were not wholly satisfactory and a different approach was needed'*.

A similar review of performance undertaken by Ogulana and Thorpe (1987,p.44) indicated that accuracy of model output was the single performance criterion that discriminated between different models. The results of their study with practitioners on the perceived accuracy levels achieved by differing models allowed them to claim that they had established the 'state of the art' in building project price forecasting. However,

Ogulana and Thorpe (1987, p.45) themselves went on to indicate in the conclusions to their work that other measures besides accuracy of model output could be used to assess performance when they admitted that '*what constitutes a "better cost (price) estimate" had yet to be adequately defined*'

Raftery (1991, p.164) picked up on that unanswered issue and pointed out that if accuracy was to be considered as being the sole criterion for the assessment of model quality and an experiment was designed in order to compare project price forecasts with eventual the tenders received for them, then the experiment would in fact be '*measuring the model's output rather than the accuracy of the model*'. The word accuracy has been derived from Latin and according to dictionary definitions, is related to being able to '*perform actions with care*'.

This definition suggested that in terms of quality we should be more concerned with how the model performs in general rather than how accurate the output of the model was. Raftery (1991) also pointed out that in practice there was no consensus as to the nature of the target with which the output of the model, namely, the forecast, could be compared. Some practitioners believed that they needed to prepare forecasts that mirrored the lowest tenders received for the projects, others believed that they were preparing forecasts for the next to lowest tenders received for the projects and yet others believed that they needed to prepare forecasts for the average of the tenders received

To consider accuracy as the sole criterion of quality in terms of building project price forecasting seems inadequate in the light of the matters indicated above and throws doubt on Ogulana and Thorpe's (1987) claim to have established the 'state of the art'.

Fig. 2.1 showed that the processes involved in building project price forecasting and it has shown that the process itself could be affected by both the technical formulation of the price forecast and the human processes involved with the interpretation and transmission or communication of the price forecast to clients. It seems that research devoted to the enhancement of quality in terms of building project price advice needs to address other factors as well as accuracy.

Other factors such as bias and consistency as well as accuracy of price forecasts when compared to actual bids accepted by clients were identified as quality issues in building project price forecasting by Skitmore (1990) following his analysis of thirty-three separate projects that were reviewed in his work on building price forecasting performance. Raftery (1991, p.164) was amongst the first to point out that the output or accuracy of forecasting models can only be of limited value as a measure of 'quality' as far as construction industry clients were concerned as it did not assess the process by which the building project price forecast had been compiled. For instance building project price forecasts, produced in particular project circumstances, may provide clients with enough robust and reliable advice upon which sound value-for-money business decisions could be made. Such advice may be found eventually to be inaccurate as a forecast when at a later date, it was compared to the final bids received from contractors competing to undertake the work.

Such a broader approach to quality and its assessment in terms of the provision of building project price forecasts was taken up by Skitmore *et al.* (1991,p.5). They suggested that 'quality' should be considered as a measure of *'the satisfaction obtained by the purchaser of the forecasts'*. It was further suggested by Skitmore *et al* (1991) that this satisfaction was a function of the purchasers perception of the usefulness of the forecasts received and that it may be influenced by factors such as, the purchasers expectations, the purchasers relationship with the forecaster, the presentation and explanation of the forecasts to the purchaser, and the impact of the cost of the forecast production on the purchasers' resources.

This approach has been echoed more recently by Kim (1998) who presented a thorough review of various definitions of 'quality' that could be applied to the development of a building project's design. Ultimately that work offered a definition of quality, in terms of building design as being *'... a measure of satisfaction as perceived by the client'*. So it can be seen from both of the above definitions of 'quality' that research into building project price forecasting needed to consider more abstract notions or measures of client satisfaction rather than just accuracy of model output as the sole criterion against which

‘goodness’ or quality of advice can be judged. This will mean that research efforts in the topic will have to embrace a multi-stranded approach that addresses the full human processes involved in the provision of building project price advice, its reception by, and action taken by the clients or forecast purchasers concerned.

Some of the human processes involved in the provision of quality building project price advice have already been identified and have been or are in the process of being investigated. For instance, Skitmore *et al* (1991, p.5) identified that work was required on issues such as,

‘(a) the nature of the target, (b) the information used, (c) the forecasting technique used, (d) the feedback mechanisms used, and (e) the person providing the forecast’.

In particular, Skitmore (1991, p.17) provided a mandate for this proposed study when he called for *‘further research into the assessment of forecast quality associated with the various techniques available’*

Lowe (1998), in his doctoral work with building project price forecast providers based in the north-west of England, investigated the feedback mechanisms and experiential learning strategies used by them to enhance the quality of the forecasts they provided. Other work investigating the person providing the forecast and the consequent potential for error and bias in the provision of price forecasts has been undertaken by Mak and Raftery (1992), Raftery (1995), Birnie (1995), and Fortune and Lees (1997).

Fig 2.2 was developed from the earlier attempt to capture the complete price advice picture that was developed by Fortune and Lees (1996) and illustrated earlier in this chapter as Fig. 2.1. Fig. 2.2 has modelled the complete building project price advice process in more detail in order to illustrate the broader base of the emerging research efforts on quality enhancement in building project price forecasting. It can be seen that the model has reflected the thinking expressed in Bowen’s (1995) communications based theory of building project price forecasting. The model indicates Bowen’s major divide in the process between the phases of forecast formulation and forecast transmission. The model has also indicated that the formulation phase of the process itself could be divided into iterative cycles of investigation and application.

The analysis of the building project price forecasting process and its illustration within the model shown in Fig. 2.2 has enabled Skitmore's multi-stranded research themes of (a) the nature of the target, (b) the information used, (c) the forecasting technique, and (e) the person providing the forecast to be located within firstly, the formulation [themes (a), (b), (c)] and, secondly, the transmission [theme (d)] phases of the process. The model also indicated the overarching significance of Skitmore's research strand (d) related to feedback and learning from previous experience. This research strand has been shown to have affected both the formulation and transmission phases of the price advice process but its impact has not formed part of the investigations carried out within the work undertaken for this thesis.

The results of the work carried out on each of the strands identified in the model of the process that was illustrated in Fig. 2.2 and needed to be put in to the context of clients and their responses to the transmitted building project price advice. In particular, further work is required in order to investigate the actual value-for-money business decisions taken by clients before 'degrees of excellence' or 'true quality' measures can finally emerge that could then be used to establish best practice in the achievement of quality building project forecasts.

Given the work previously done in the field and the illustration of the building project price advice process illustrated in Fig. 2.2 it was resolved to limit this work to the investigation of the forecast formulation phase of the building project price advice process. Accordingly, this research addressed issues related to Skitmore's research theme (c), namely, the forecasting techniques themselves. In particular the study will identify factors that affect the selection of differing types of building project price forecasting models used by the construction professionals most often involved with them in England, namely consultant quantity surveyors. This section has defined 'building project price forecasting' and 'quality enhancement' in terms of building project price advice. It has identified the previous as well as current research themes and assessed their context and relevance for clients, cost consultants, and other researchers in the field

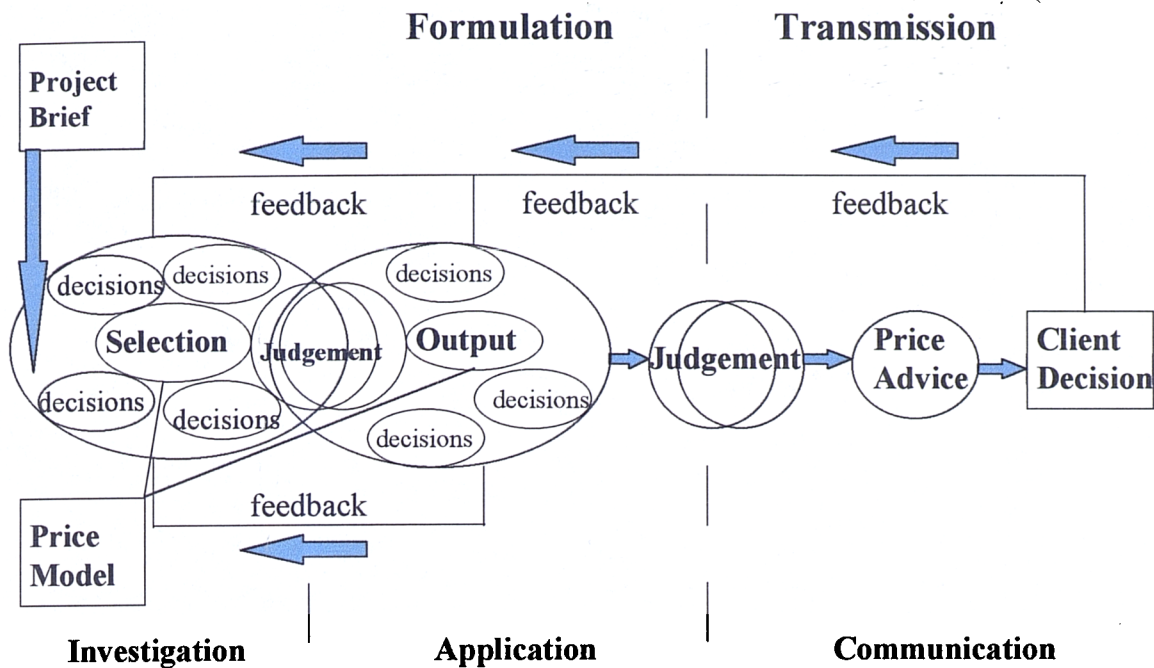


Figure 2 - The Building Project Price Forecasting Process

The main thrust or focus for this study, the enhancement of quality building project price forecasts, has been set out in general and its context and relevance has been illustrated in Fig 2.2. In particular, the work focused on the factors affecting the selection of appropriate models within the investigative phase of the building project price forecast formulation process.

The previous work done in this particular subject area will now be reviewed to establish the context, assumptions, and boundaries of what is already known.

The review will firstly consider a chronology of material related to building project price modelling in general, and then secondly, material that has identified models that could potentially be used by practitioners in the field. The establishment of the models actually used in practice was seen as being an essential first step in the identification of criteria that influence the selection of building project price forecasting models themselves. Finally, the work reviewed material related to model classification systems that have been advanced by academe and which could be used to group models with similar characteristics together in order to facilitate further empirical study.

2.4 Previous work

2.4.1 General background

Bowen and Edwards (1998,p.16) identified that the models or tools used to produce building project price forecasts have been the '*focus for research over the last thirty years*'. The history, development, assessment in use, and development of new initiatives in building project price modelling have been well documented in works by Morrison (1984), Raftery (1984), Ashworth (1986), Bowen and Edwards (1987), Ogulana and Thorpe (1987), Raftery (1991), Ferry and Brandon (1991), Newton (1991), Mak and Raftery (1992), Raftery (1995), Fortune and Lees (1996), and Bowen and Edwards (1998).

Ashworth (1986,p.2), Raftery (1991, p.169), and Ferry and Brandon (1991, p.106) identified an '*evolutionary development of models through three distinct generations*' that they saw stretching back over the last three decades. Ashworth (1986, p.2) reported that the first generation of models originated in the 1950s and the 1960s. Such models in-use at that time were described by Ashworth as being '*single point deterministic models*' that were essentially procedural in nature. Models in widespread use at that time included, the superficial, the storey-enclosure method, and the cubic method. An initiative during this period was the development of the approximate quantities and elemental cost planning methods. The RICS developed and published the building cost information services (BCIS) in 1962.

This subscription service published analyses of past schemes that were capable of being updated for time, quantity and quality. The nature of these analyses formed the basis of cost plans and were expressed in terms of cost per £/m² and were considered to be an aid to design cost control. Any adjustments that were required to the model were carried out in what Ashworth described as being '*a naive straight line way*'. It was considered that professional judgements on matters such as design quality assessment adjustments could be more easily determined and assessed using the separate approximate quantities technique.

The literature reviewed indicated that the 1970's saw the development of a second generation of building project price forecasting models. This period saw the development of more mathematically based models such as regression analysis and time series models (McCaffer, 1975). This period also saw the initial development of statistical models capable of being used on the newly available cheaper micro-computers that were being derived from the large expensive mainframe computers that were then available but were not in widespread commercial use due to their prohibitive costs.

The third generation of models developed in the 1980's reflected a greater willingness on the part of building project forecasters to admit to the existence of uncertainty and imprecision. This resulted in a desire to develop models that could take account of uncertainty by using probability and case based reasoning. This led to models such as monte carlo analysis and expert knowledge based systems being developed. Ogulana and Thorpe (1987, p.44) acknowledged that the driving force behind these developments was the perceived need to utilise the newly emerging information technology to produce more accurate predictions of building project prices than those that were then currently produced in practice as well as providing '*an explicit measure of the risks associated with the proposed project*'. Another factor that must have influenced the development of these 'third generation of models' must have been the general availability of desk-top computing facilities at what were then considered to be more reasonable rates.

Ogulana and Thorpe (1987, p.44) in their 'review of the state of the art' identified a '*fourth approach*' that was then emerging in the late 1980's. This newer approach was centred on the use of more data in the process of building project price forecast preparation. Ogulana and Thorpe identified that the BCIS system was now providing an 'on-line' service to its members and claimed that it was then widely used in practice even though its performance in terms of accuracy of its output had at that point not been measured and reported. Ogulana and Thorpe went on to suggest that the latest model to be developed was the '*resource based or contractor type models*' that sought to model costs on the basis of how they arose rather than on a notional basis of how they should be measured once they were in place.

Although the development of these newer models could be identified as a separate approach it is still appropriate to classify them as belonging to the third generation of building project price models as they sought to reflect the risk and uncertainty inherent in the development process by utilising the newly emerging information technology.

The 'three generations' of building project price forecasting models that have been identified above may be said to have reflected the available models, computerised aids and mind sets of the building project price forecasting practitioners involved in the problem solving process over that period of years. The research that had been undertaken on building project price modelling during Ashworth's three generations of cost model development was given focus in the early 1990's by Newton (1991) who attempted to set out an agenda to take forward further work on the topic.

Newton (1991) produced what can be termed as a seminal paper, in terms of this work, which reviewed the literature available on the topic upto 1989. He identified over fifty construction cost models that had been developed by academia up until that point. Following analysis Newton developed a number of '*descriptive primitives*' or pegs upon which the identified cost models could be classified.

The majority of the cost models included in Newton's paper did not fit the definitions of building project price forecasting model types set out in the scope and context for this thesis in section 2.1 of this chapter. The majority of the models listed in Newton's work were in fact constructors 'cost' models rather than clients 'price' models. Numbers of the models listed were more suited to modelling the civil engineering and chemical process industries rather than the building project process within the construction industry. As well as the classification system advanced in the paper, Newton also identified other contributions that were considered as being '*key or position papers*' amongst the literature then available.

The first '*key*' paper that was identified by Newton (1991) was the paper published by Brandon (1982). That paper was presented to the Building Cost Research Conference held at Portsmouth Polytechnic in September 1982 and it signaled a clear dissatisfaction

among academics with existing methods used by practitioners to provide early cost advice. The paper called for a change in paradigm away from traditional methods that had been developed in the 1950s and the 1960s and were still in widespread use. Brandon also called for a more substantial body of theory and better models which were more capable of reflecting the risks and uncertainties involved in the construction process on which to base future practice. Brandon suspected that the impetus for change from traditional models would come from advances in computer technology and that there would be, in time, a more widespread application of realistic simulation techniques to the building project price forecasting process.

Brandon also felt that it would be unlikely that construction professionals themselves would call into question the usefulness of the methods or the techniques that they were currently using, as to do so would be to call into question the value of the service that they were providing to their clients. Brandon went on to provide a clear mandate for this study when he stated that it was important to question the role of modelling and develop an understanding of how all of its various techniques could be applied in order to assist practitioners consistently adopting a '*status-quo*' approach to the formulation of their building project price forecasts.

Newton (1991) considered that Brandon's work could be considered as '*a flare that floodlights the subject area*'. Given the attention that this paper has subsequently been given by researchers on the topic then there can be no doubt that Newton was indeed correct to identify it as a '*key*' paper.

The next paper highlighted by Newton (1991) as being a '*key*' piece of work was a paper by Bowen and Edwards (1985). That paper was concerned with the limitations of the then current paradigm, the claims of a replacement paradigm, and the quantitative aspects of cost modelling and price forecasting. In this context they considered Brandon's (1982) call for a shift away from what Bowen and Edwards termed as the '*historical deterministic approach to cost modelling and towards a concept of stochastic simulation*'. The goal of such a shift in approach was to incorporate a more explicit consideration of the uncertainty and variability involved in forecasting the prices paid for

building work that was to be undertaken in the future. Bowen and Edwards asserted that, in their view, the pressure to consider a new paradigm came almost entirely from *'the academic pursuit of knowledge'*.

Bowen and Edwards maintained that there was no evidence of demand from building project forecast consumers for more realistic price forecasting. Instead they saw the called for 'paradigm shift' as a reflection of *'the journey of quantity surveying from a technical to a scientific discipline'*. This view contrasted with the view of Ashworth (1986, p.1) who maintained that the more complex techniques would become more widely used *'in order to satisfy the demands of the client'*. These two contrasting views illustrate one of the unresolved issues which this study sought to address, namely, the identity of the main drivers for change, in terms of the use or non-use, of particular types of building project price forecasting models by construction professionals in the field.

Nevertheless, Bowen and Edwards (1985) set out the case for the adoption of a new paradigm for building project price forecasting. They pointed out that price forecasting models drawn from the existing paradigm were predominantly historical and deterministic in approach. The strengths of such an approach were highlighted as being *'.. its structure which was set out in a hierarchical manner which paralleled the design process ... and was relatively easy to understand and follow'*. Bowen and Edwards (1985) firmly supported Brandon's (1982) call for a paradigm shift in models-in-use and pointed out that the main problem with using models drawn from the current paradigm was that they

'failed to reflect the process by which buildings were produced: and that they did not explain the strength of the relationships between building prices and the independent factors that affected building project prices'.

Ashworth's (1986) paper echoed similar issues in relation to the problems inherent with the building project price forecasting models in-use in the paradigm that was current at that time. Ashworth (1986, p.1) asserted that *'these traditional processes were a poor representation of costs, since they did not really model costs in the manner in which they occurred'*. Indeed Ashworth went further and suggested that in order for real quality enhancement to be achieved in terms of building project price forecasts actually

produced then it would be necessary to '*adopt more radical methods*' than those that were currently in widespread use.

In essence, Ashworth and Bowen and Edwards' work highlighted the main problem with the traditional or conventional models. Their work showed that the models then in current use failed to reflect the technological and cultural changes that had taken place in society as well as in the construction industry during the 1950's, 1960's, and the 1970's. In terms of society at large these changes were summed up by Brandon (1982) when he identified the fact that often insufficient time was available to investigate properly the enormous number of potentially feasible project design solutions available to solve clients needs. Brandon (1982) went on to assert that the '*prevailing systems (building project price forecasting models) were inadequate to cope with the (then) increased pace of society*'.

Bowen and Edwards (1985) noted that, as at that date, practitioners in the field had not yet made the 'paradigm shift' in approach to building project price forecasting that had been called for by Brandon in 1982. They asserted that the following were potential reasons for such a change not yet being adopted at that time,

'(i) the traditionally conservative attitude towards change within the professions, (ii) model blindness amongst practitioners, (iii) the substantial database that would be necessary to support the formulation and maintenance of mathematical cost models. (iv) many practitioners were baffled by the science of statistics and were afraid to admit our own ignorance'.

It may well have been somewhat optimistic to expect construction professionals in the field to have adopted a new paradigm in approach to an essentially practical problem in such a comparatively short space of time, namely from 1982 to 1985. On reflection there could have been only few organisations at that time which had the technological capability as well as the necessary cost databases to facilitate the switch away from traditional models and towards the newer more stochastic computerised models.

Nevertheless, Bowen and Edwards (1985) concluded that the new paradigm would evolve in time through the adoption of more mathematically based techniques such as regression analysis. In addition they felt that the newly developed knowledge based

expert systems would be central in persuading practitioners to adopt the stochastic models that were expected to be a feature of the new paradigm. It was noticeable that Bowen and Edwards presented no empirical evidence in their paper to support the reasons advanced for the non-adoption of the new paradigm in the production of building project price forecasts by construction professionals in the field.

The final piece of work that Newton considered to be a 'key' contribution to the field was the paper by Skitmore (1988). Newton (1991) pointed out that cost modelling research up until that time had no formal system of describing one cost model relative to another. Skitmore's work set out the first descriptive primitives (labels or terms) that were capable of being generally accepted. Research on the topic up until that point was termed as being individual technique bound and following this contribution it was possible to undertake comparative studies on differing models in terms of their relative outputs.

Newton's (1991) paper itself can also be considered as a 'key' piece of work in its own right in terms of this study. This is because it not only brought together and classified a great number of separate cost models but it also attempted to identify an appropriate pattern for the model identification and model output centred research patterns.

Newton (1991, p.102) also provided a mandate for this study when he commented that *'the principal question in cost (price) modelling concerned the role of the model ... and the context and use of the model needs to be better understood'*. In general Newton's seminal paper set out *'the overall topology of cost modelling as a subject'* as it had developed up to that time. Newton acknowledged in his paper that he had hoped to *'provide the points of reference on which individual research contributions (of the future) could be located'*.

However, the research agenda on building project price forecasting has moved on from what Newton had envisaged in the early 1990's. It is no longer entirely focused on the forecasting model and its product. in terms of model output. This shift in emphasis has caused Newton's *'research agenda'* to become out of focus with the thrust of more

contemporary work undertaken by other researchers in the subject area during the 1990's.

Currently in the late 1990's there seems to have emerged two distinct schools of research in connection with the enhancement of quality in terms of building project price forecasting advice. The pace of technological change and the growing realisation that the *process* of building project price forecasting was as important as the *product* has caused the current research agenda to split into two separate spheres of development.

There is presently a school of research which may be described as being 'hard edged'. This approach centres on the further development of computerised models. Such models seek to capture and utilise the latest information modelling procedures in order to provide an integrated approach to the provision of building project price advice. The alternative school of research adopted a more 'softer edged' thrust. This approach seeks to develop a greater understanding of the human processes needed to provide quality advice to clients.

In terms of the 'hard edged' school of research Newton (1991) could not have fully imagined the extent and pace of such technological advances during the 1990's and the potential such advances have created for technology transfer and project data integration. This recent period in the 1990s has seen the development of prototype object orientated models (OSCON) that seek to model the entire construction design and development process. Such developments have been reported by Aouad *et al* (1993, 1994), Aouad (1998), and Elhag and Boussabaine (1998).

Such developments seek to use neural networks and object orientated information modelling as the mechanisms and the media to enhance the formulation of the building project price advice. They seek to improve the communication of the price advice itself by developing a standardised set of process protocols which in turn would ensure a shared understanding amongst all the stakeholders in a project. Such work on technology transfer by Aouad *et al* (1998) seeks to develop computerised tools that practitioners will use to model the entire building project process from inception, through

design, budgeting, construction, occupation, and finally demolition. Increased reliability and usefulness in terms of building project price advice was seen as being developed as essentially a 'by-product' of this new wave of expert systems. It could well be that the widespread adoption of such tools would facilitate a future re-focused paradigm shift in approach.

However, Boussabaine (1996, p.434) acknowledged that despite the ability of a trained neural network to aid decision making in areas such as the prediction of cash flow and costs, risk analysis, and resource optimisation, there has been no work done, at present, on its application to the forecasting of building project prices. As yet, the potential benefits of neural networks have made little impact on the construction industry and Boussabaine acknowledged (1996, p.434) that *'some academics and construction managers were suspicious of such artificial intelligence systems and so these applications were still in their infancy'*

The take up and usefulness in practice of these 'leading edge developments' is presently on-going and so it is too soon to make any assessment of their impact with building price forecasters on the ground in England and so cannot as yet be assessed. Accordingly it has not been proposed to address issues related to the assessment of the effectiveness of such new leading 'hard edged' developments within this study as it has been undertaken contemporaneously with their development during the 1990's.

The CIBW55 symposium on building economics held in Lisbon in 1993 provided the first indications that there was an alternative 'softer edged' school of research to the 'hard edged' or 'model centred' research school related to building project price forecasting that was emerging in the 1990's. Skitmore (1991) had begun the process of recognising that humanist issues related to bias, heuristics, and error could affect the potential accuracy of the forecasts generated by practitioners in the field. These concerns were taken up and addressed in a keynote paper delivered to the symposium by Raftery (1993).

In the paper Raftery argued that the fundamental basis of the alternative research paradigm was flawed in that it had believed that the people involved in the building project price forecasting process consistently acted in a logical and rational manner. Raftery pointed out, in what may be considered as a '*flare*' in terms of this work, that the adoption of such logical and rational thought processes did not reflect how people behaved in the real world and that the alternative 'hard edged' research paradigm had ignored the potentially biased, erroneous, and irrational behaviour of the construction professionals involved in the process.

This view was taken up again by Raftery (1995) and other researchers active in the field, notably, Bowen (1995), Birnie (1995), Bowen and Edwards (1996), Fortune and Lees (1997), and Lowe (1998). Their work has established a re-focused alternative research paradigm that now seeks to address the human or 'softer' issues involved in the building project price forecasting process and thus the potential to develop the enhancement of its quality.

Literature published by Bowen and Edwards (1993), Bowen (1995), and Bowen and Edwards (1996) looked at the building project price forecasting process in terms of it being an interpersonal communication process between the forecast sender and the forecast receiver. Their work with construction professionals and clients was based in South Africa and developed a communications based theory that identified the message transmission process as the critical phase in the building project price forecasting process. It was asserted by them that the more effective the inter-personal communication activities at this stage of the process then the more likely the forecast receiver would be satisfied with the advice received. Bowen and Edwards (1996, p.396) asserted that it was the forecast sender's responsibility to

'ensure that the appropriate receiver is selected, the most appropriate medium is chosen, the message contains the correct content (i.e. the most appropriate forecasting model is used) and that there were no barriers inhibiting the ability of the receiver to accept the message'

Bowen and Edwards (1996, p.400) also acknowledged that although there were standardised methods of measurement or guidelines for the measurement of building work once the initial design stage was completed, there were no similar guidelines available for practitioners involved with the formulation of building project price advice. Indeed they commented,

'given the fact that various types of forecasting models, using different forms of cost data were often employed at differing stages throughout the design phase could risk creating a communications gap'. They called for more research to be directed towards

'the communication needs and patterns that constituted the costing (price formulation) processes themselvesand the communication characteristics of the cost (building project price forecasting) models themselves will have to be identified and assessed'.

Bowen and Edwards felt that a greater understanding of the human or 'softer edged' issues involved in the processes of forecast formulation would enhance the quality of the information on which clients could make effective decisions.

Birnie (1995) reported empirical evidence on the existence of bias and error in the way in which the building project price forecast itself was compiled. Data had been gathered for this study from contractors estimators and it was noted that they were affected by anchoring and adjustment in the way in which they compiled the rates for the work items under consideration.

Fortune and Lees (1997) responded to the call of Raftery (1995) to consider the *'actual rather than theorized'* behaviour of practitioners involved in the real world provision of building project price advice. Fortune and Lees (1997) acknowledged Bowen, and Bowen and Edwards previous contributions and resolved to look at the human issues involved in the intra-personal communication process upto the actual transmission of the building project price advice message being transmitted to the client. A number of pilot studies were undertaken with student practitioners and the generated data, when analysed, revealed the presence of error and bias

Lowe (1998) reported an empirical study with consultant quantity surveyors that examined their use of feedback from the forecasts that they provided for their clients. Although the work was measuring accuracy of model output in terms of its comparison to the actual tendered bids for the projects under consideration it nevertheless reflected the human or softer focus of the redefined research paradigm on building project price forecasting. In particular Lowe (1998) sought to assess how the practitioners involved learned from their experiences. Although Lowe's work concluded that few practitioners went about learning from their

experiences in any organised manner the work nonetheless made a contribution to the people focused research paradigm currently becoming established.

This study, centred as it is on identifying the factors that affect the selection of building project price forecasting models in-use contributes towards the better understanding of the intra and inter personal communication processes which was called for by Bowen and Edwards. Therefore, this study is part of the alternative 'softer edged' research paradigm that is currently addressing quality enhancement of building project price forecasting. The proposed thrust of this study was recently given a further mandate by Bowen and Edwards (1998, p.16) who in their review of cost planning techniques in-use in South Africa commented, *'it is important that the investigative process of cost planning not only used appropriate data but also the most appropriate techniques'*.

The work has helped to establish the *'applications based'* research paradigm more firmly and it has brought that together the model-centred school of research, as championed in the past by Skitmore (1990) and Newton (1991), and currently by Aouad *et al* (1994,1998), and the forecast preparer and user or *'people-orientated'* school of research, as championed by Raftery (1993), Bowen (1995), Bowen and Edwards (1996), Fortune and Lees (1997), and Lowe (1998).

The establishment of such an applications based research theme in general, and the eventual development of a tool or guide to assist practitioners in the building project price forecasting model selection process in particular, will need to consider factors related to the attributes of (i) the client or forecast users, (ii) the forecast preparer, (iii) the forecaster's organisational setting, and (iv) the forecasting models themselves. As a first step towards the establishment of an applications based school of research this work needed to identify the building project price forecasting models that were available to be selected by practitioners for use.

2.4.2 Identification of potential models-in-use

Standard textbooks such as those by Seeley (1985), Gruneberg and Weight (1990), Skitmore and Patchell (1990), Raftery (1991), Ashworth (1994), Ferry and Brandon (1994), Morton and Jaggar (1995), and Ashworth (1996), as well as refereed technical research reports such as those by Ashworth (1986), Raftery (1991), Skitmore (1991), Bowen (1995), and Fortune and Lees (1996), together with refereed papers in academic journals and refereed conference proceedings such as those by Bowen and Edwards (1985), Birnie and Yates (1991), Newton (1991), Akintoye *et al* (1992), Tah *et al* (1994), and Ross *et al* (1996) have between them identified all known traditional / manual deterministic as well as newer computerised stochastic building cost forecasting techniques suspected as being in use in 1996.

The literature reviewed has been presented in a sectionalised manner and numbered to facilitate identification, referencing, and summary in Table 2.1

Standard Textbooks

- (1) Seeley (1985, ch.6), in what has been acknowledged as the leading textbook of the 1980's identified the following models as being the techniques available to practitioners, namely,
'the conference, the comparison, the graphical, the unit, the superficial, the superficial perimeter, the cube, the storey enclosure method, the functional approach, the interpolation method, the resource estimate, the factor estimate, the exponent estimate, the approximate quantities method, the elemental method and the process method'.
Seeley (1985) also identified techniques such as, *'multiple regression and monte carlo simulation'* as being the newer computer based techniques of the future.
- (2) Gruneberg and Weight (1990, ch.4) identified the following models as being in use, *'judgement, the unit method, the floor area method, the approximate quantities method, builders resource estimating, elemental cost analysis'*. Gruneberg and Weight (1990, ch 6) went on to identify developers *financial models, life cycle cost models, value related models*, and the newly emerging computerised cost models such as *'patterns and spacewrapping'* that had been developed but had not yet, at that point been made commercially available.

- (3) Skitmore and Patchell (1990, p.82) set out their taxonomy of traditional and newer price forecasting models allegedly available within Brandon's textbook on new directions in quantity surveying. The models that were identified by them included, *'the unit method, the functional method, interpolation, the floor area method, the cubic method, the storey-enclosure method, the elemental method, the approximate quantities method, the detailed quantities method, and the significant items method'*
- (4) Raftery (1991, p.172) identified the *'elemental based floor area model, the regression model, and the probabilistic/ monte-carlo model'* as being the types of models that were thought likely to be in use and worthy of further investigation
- (5) Ferry and Brandon (1994, ch 9), in the leading textbook of the 1990's listed the following techniques which they termed as 'traditional', namely, *'the unit method, the cube method, the superficial area method, the storey enclosure method, and the elemental analysis method'*

Ferry and Brandon (1994, ch.3) also identified the following methods which they claimed had not yet been accepted as conventional in practice, namely,

'judgement without quantification, principal item method, significant items method, causal cost models, time series models, risk analysis, and knowledge based systems'.

In addition, Ferry and Brandon (1994, p.37) identified that the following types of life cycle cost models were available for use by the profession in general, namely, *'net present value, payback method and discounted cash flow'*. Models more closely aligned to the way in which construction costs arose in practice were listed by Ferry and Brandon (1994, p.153) who termed them as *'contractors resource cost models and contractors process cost models'*

Ferry and Brandon (1994, p.253) identified that the following types of cost (price) models were typical of the newer computerised stochastic models that were likely to be used in the future, namely, *'causal cost models, regression models and monte carlo simulation'* In addition Ferry and Brandon (1991, p.311) identified that the increasing pace of technology would bring into common use intelligent knowledge based systems such as *'ELSIE and other commercially available expert systems'*

- (6) Ashworth (1994, p.86) listed the following as being the methods of pre tender price estimating, namely,

'the unit method, the superficial method, the superficial perimeter method, the cube method, the storey-enclosure method, the approximate quantities method, and financial models'.

In addition Ashworth confirmed that *life cycle cost models* would increasingly be seen as the models of the future as clients moved to consider whole life costs rather than being solely concerned with initial building costs. Ashworth (1994, p.273) when considering the way forward in terms of building project price forecasting listed the following as being the models that would be adopted in the future, namely, *'mathematical models, regression analysis, value management, and expert systems'.*

- (7) In a further textbook on the subject Ashworth (1996, p.214) confirmed many of his previous findings and listed a variety of other models that he alleged were in use at that time. They included the

'conference method, the financial method, the unit method, the superficial method, the superficial-perimeter method, the cube method, the storey-enclosure method, the approximate quantities method, the elemental estimating method, causal cost models, and expert systems'.

- (8) Morton and Jaggar (1995, p.292), identified *'the unit method, the superficial method, the storey-enclosure method, and the approximate quantities method'* as being the methods in common use at the early design stages of most building projects.

However, Morton and Jaggar went on to indicate that they thought that clients in the future would become more concerned with whole life cost forecasts than they currently were, in which case life cycle cost models would also become much more used.

Refereed Technical/Research Papers

- (9) Ashworth's (1986) technical paper for the CIOB was the first of the refereed technical reports covering issues related to building project price forecasting that was

included in this review. Ashworth (1986, p.3) identified the following methods which he asserted could be used for cost (price) modelling purposes, namely, *'empirical methods (judgement without quantification), regression analysis, monte-carlo simulation, construction cost simulator, heuristics (expert systems)'*.

Ashworth (1986, p.5) also acknowledged that, despite considerable publicity amongst the professions and industry, the models listed had, at that point, *'failed to achieve application in almost every quarter'*

- (10) A refereed technical paper by Raftery (1991, section 5) for the RICS identified a taxonomy of techniques which included,

'the unit method, elemental analysis method, costs per m² method, resource models, process models, construction cost simulator, regression analysis, monte carlo simulation model, time series models, life cycle cost models, ELSIE, and other knowledge based systems'

- (11) Skitmore (1991, p.16), in a paper published in the RICS technical paper series reviewed the performance of building project price models and identified the following models as being available for use, namely,

'the conference estimate, the comparison estimate, the graphical method, the unit method, the functional approach, the cube method, the storey enclosure method, the superficial method, the resource estimate, the factor estimate, the exponent estimate, the approximate quantities method, and the detailed quantities method,'.

Skitmore (1991, p.16) also indicated that the statistical methods of *'regression analysis and expert systems'* were available but he asserted that as yet there was *'little evidence of their practical application'*.

- (12) Bowen (1995) in a paper published in the RICS research paper series advanced a communications based theory of building price forecasting. In order to develop the theory Bowen reviewed some of the available literature and identified the following models as being available for use by practitioners in the field, namely,

'comparative methods, parametric methods'

Refereed Academic Papers

- (13) Birnie and Yates (1991) in their paper in the leading academic journal of construction management pointed out that the cost (price) prediction methods currently in-use have relied upon the subjective judgement. Birnie and Yates (1991,p.171) acknowledged that '*risk analysis methods such as decision trees, utility theory and monte-carlo simulation*' were available but '*little used in construction*', but they nevertheless believed that they had a potential contribution to make in the production of better quality building project price forecasts.
- (14) Newton (1991, p.97) noted that there had been up until then '*little order or formal direction to cost (price) modelling research*' and in the attempt to create some order he brought together and produced an encyclopaedic list of cost models. However Newton (1991, p.103) listed a total of fifty-six separate models (by author rather than by type) that had been advanced by academics between 1960 and 1989. The models listed by Newton (1991, p.103) were classified by the following nine major parameters, namely, "*relevance, units, cost/price, approach, time-point, model, technique, assumptions, uncertainty*". Of Newton's parameters the most critical to this study were the parameters which referred to '*cost/price, time-point, and approach*'.

Newton classified the models identified in his paper according to whether they were seeking to model contractors actual '*costs*' or whether they were seeking to model the '*prices*' that clients would have to pay contractors in order to obtain their completed building. Given the nature of this study it was necessary to review Newton's work and exclude those models that were seeking to model contractors costs. Accordingly some four models that were listed by Newton were found to be outside the scope of this study.

A further critical classification of the models identified by Newton, in terms of this study was '*approach*'. Newton used this classification label to distinguish between those models that were addressing a potential building projects price in its totality

(macro), or models that were addressing a building projects price only in part (micro). Given the nature of this study it was necessary to review Newton's work and exclude those models that were seeking to model prices on only a micro level. Accordingly, some ten models that were listed by Newton were found to be outside the scope of this study.

Newton's classification styled 'time-point' was also a critical parameter in terms of this study. Newton had identified models (nc) that were appropriate for the chemical and process industries rather than the building industry as well as models that were only suitable for application at the detailed design and tender stages (d & t) in the development of a projects design. Given the nature of this study it was apparent that models that were classified as indicated above should be excluded. Accordingly, some four models that were listed by Newton were found to be outside the scope of this study.

Given the above analysis, and allowing for models being excluded for only one reason, then the fifty-six models listed by author by Newton (1991, p.102) were reduced to forty in total. Of the forty authors listed the following eight actual models were identified,

'dynamic programming (1 author), expert systems (1 author), functional models (12 authors), linear programming (3 authors), manual / traditional models (4 authors), monte-carlo simulation (3 authors), networks (1 author), and regression analysis (15 authors)'

Newton (1991) acknowledged that his *'review was not intended to be exhaustive'*, and he acknowledged that amongst the models excluded were *'life cycle cost models, value engineering, time related models and most bidding models'*.

However it was apparent that the work had adopted a rigorous approach to the identification of models that were in theory available for building project price forecasters to apply.

- (15) Akintoye *et al* (1992, p.110) reported one of the few empirical studies undertaken with construction professionals in the field. In a small scale postal survey of twenty-nine quantity surveying organisations that were operating in Nigeria they established that the following methods were in use, '*the unit method, the cube method, the superficial method, the elemental estimate, and the approximate quantities method*'. Akintoye *et al* (1992, p.110) found some use of the '*storey-enclosure method*' but only by a very small minority of the respondents to that survey. Akintoye *et al* (1992) commented that the most popular method in use was the approximate quantities method. The popularity of such an unsophisticated traditional approach as the approximate quantities method, caused them to comment that, as the method itself could not be utilised until the major design decisions had been taken, then '*it was not surprising that a lot of projects initiated in both the private and public sectors of the economy (of Nigeria) had been abandoned due to cost overruns*'.
- (16) Amongst other empirical studies reported in relevant refereed academic journals that were concerned with building project price forecasting models in-use within contracting organisations were papers by Tah *et al* (1994), and Ross *et al* (1996). Tah *et al* (1994) reported a further empirical study on indirect cost estimating practices within contracting organisations. It was found that the methods in use were highly subjective and mainly relied upon practitioners '*judgement*'. Methods that involved statistics and probability although advanced as being useful by academics were rarely used. The survey was undertaken with a small sample and so its results could not be taken as being representative of the industry as a whole.
- (17) The work by Ross *et al* (1996, p.90) with the top one hundred design and build organisations in England can be taken as being representative of that population due to the high (81%) response rate achieved by that survey. Amongst the building project price forecasting methods found to be in use were the following models, '*judgement, functional unit, superficial method, cube method, approximate quantities, detailed quantities, elemental analysis, interpolation method, regression analysis, ELSIE, net present value, resource models, process models, monte-carlo simulation, and value management*'
-

Given the subject frame for the survey it might have been expected that the survey's results would have reported that production related models such as resource and process based models would have been in more use than they were found to be.

These 'key' works have between them identified all known models from the literature that was current and available in 1996 and form an updated taxonomy of the theoretically available building project price forecasting models. The models identified have been presented in Table 2.1 together with an indication of their academic strength in terms of the numbers and types of sources that identified them as being either in use, or available for use by practitioners in the field. In addition the table has attempted a rudimentary classification of the models that have been identified by indicating their method of application. This classification was based on one of the classifications used by Newton (1991) to discriminate between models with differing characteristics.

It was apparent that models which were classified as manual in their application corresponded with models that had been described as 'conventional' or 'traditional' in some of the other sources quoted above. Table 2.1 also revealed that the 'newer' or 'computerised' models had been identified in the more academic sources (ref. nos. 9-17) reviewed above, whereas the 'traditional' models were more likely to have been identified from the more practically based textbooks (ref. nos. 1-8) in the subject area that were also reviewed above. It was also apparent that the literature reviewed contained few empirical studies of actual models used by building project price forecasters in the field.

Of the material reviewed, only work by Akintoye *et al* (1992), Tah *et al* (1994), and Ross *et al* (1996) had made any attempt to find out which of the theoretically available models were being used by practitioners in the field. Only the empirical work undertaken by Ross *et al* (1996) was based in England and none of the empirical studies reviewed had ascertained any information from the subjects most directly concerned with the selection and use of the models in England, namely, the consultant quantity surveyors. This gap in the literature available has indicated the extent of existing knowledge on the topic and it has provided a mandate for the main thrust of this study, namely the identification of the building project

Table 2.1 Models identified as available for use

Nr	Model Type	Sources (Nos. indicate refs in text)	Manual/ Computer
1	Conference	1, 7, 9,11	Manual
2	Comparison	1, 11,	Manual
3	Graphical	1, 11	Manual
4	Unit	1,2,3,5,6,7,8,10,11, 15	Manual
5	Superficial	1,2,3,5,6,7,8,10,11, 15,17	Manual
6	Superficial Perimeter	1,6,7,15	Manual
7	Cube	1,3,5, 6,7,11,15,17	Manual
8	Storey-Enclosure	1,3,5,6,7,8,11,15	Manual
9	Functional	1,3,11,14*,17	Manual
10	Exponent	1,11,	Manual
11	Interpolation	1,3,17	Manual
12	Resource	1,2,5,10,11,14*,17	Computer
13	Factor	1,11	Manual
14	Approximate Quants	1,2,3,6,7,8,11,15,17	Manual
15	Elemental Analysis	1,2,3,4,5,7,10,15,17	Manual
16	Process	1,5,10,17	Computer
17	Regression Analysis	1,4,5,6,9,10,11,14*, 17	Computer
18	Monte-Carlo	1,4,5,6,9,10,14*,17	Computer
19	Judgement	2,5,9,16,17	Manual
20	Financial	2,6,7	Manual
21	Life Cycle Costs	2,5,6,8,10,14,17	Computer
22	Value	2,6,14,17	Computer
23	Expert Systems	2*,5,6,7,9,10,11,13,	Computer
24	Detailed Quants	3,11,17	Manual
25	Significant Items	3,5	Manual
26	Principal Items	5	Manual
27	Time Series	5,10	Computer
28	Causal Costs	5,7	Computer
29	Risk Analysis	5,13	Computer
30	Con Cost Simulator	9,10,14	Computer
31	Dynamic Programme	14	Computer
32	Linear Programmes	14	Computer

* Indicates sources identified by multiple references

price forecasting models actually in use in England and the determination of the factors that affected their selection.

In order to achieve the main aims of the work it was decided to give the 'taxonomy' identified above a better shape and clearer focus. It was decided that there was a need to group models with similar characteristics together. Such a grouping or classification system would also enable the study to find out what models consultant quantity surveyors actually made use of in the process of providing building project price advice. It was therefore necessary to review the model classification systems already advanced by academe so as to determine their appropriateness

2.4.3 Model classification systems

Given the literature available it was apparent that there had been several attempts by academics to classify the building project price models theoretically available. In terms of chronology Ashworth (1986) observed that there were some early attempts in the 1960's and 1970's to provide a framework within which the available models could be located. However, given the technological and cultural changes in society since that time it was decided to give more credence to the classifications attempted in the 1980's and the 1990's.

Beeston (1983, p.58) advanced one of the first classification systems for building project price models. The models available at that time were classified by Beeston as being either 'black box' or 'realistic'. Beeston made clear that the label 'realistic' was to be applied to contractors methods which utilised direct costs of resources.

Skitmore (1983,p.11) added to the complexity of the available classifications by identifying that there were '*basically two types of cost models, firstly design models, and secondly, contractors production models*'. Raftery (1984) in his doctoral work on cost models defined models in terms of '*data, data/model interface, model technique, interpretation of output, and decision making process*'. This work established useful criteria on which a particular model could be judged but it failed to give specific advice

on how the data, the data/model interface may be sub-divided. Bowen and Edwards (1985, p.207) reflected the growing number of newer more computerised models that were becoming available when they advanced their classification system which used the following categories, namely, '*traditional deterministic, mathematical, or capable of stochastic simulation*'.

Ashworth's (1986, p.2) work on the history and development of cost models identified previous attempts by Draper and Smith, and Hull (1976) to group building project price models together. Such classifications were considered to be too far away from the present state of knowledge or the present state of technology to be valid and so have not been considered. Ashworth (1986, p.3) himself used the following definition as the basis of a more fundamental classification of models that were then available for use. Ashworth's classification had the following main categories, namely,

- '(i) empirical models, which were based on observations, experience, and intuition and made use of common sense methods of understanding, application, and presentation,
- (ii) algorithmic models, which were precisely defined step by step procedures for determining the optimum values of the variables in model building
- (iii) simulation models, which sought to duplicate the behaviour of the system under investigation by studying the interaction amongst its components, and
- (iv) heuristics, which sought to determine a rule of thumb procedure that allowed a near optimum solution to be reached once the model had been built'.

Raftery (1991, p.62) advanced a straightforward system that sought to classify models according to the dominant characteristic associated with them. Accordingly the following classification system was developed, '*deductive models, inductive models, optimisation models, and stochastic models*'.

Newton (1991, p.99) developed some 'descriptive primitives' or 'pegs' in order to group the many different types of model reviewed within that paper. In such circumstances the categories offered could only be general in nature and were as follows, '*relevance, units, cost/price, approach, time point, technique, assumptions, and uncertainty*'. Although

Newton's (1991, p.108) work has been acknowledged as being encyclopaedic in nature he himself suggested that the descriptive primitives advanced in the paper were intended to form a supporting framework and that they may be '*only one of the many possible ways in which to classify cost models*'.

In the standard textbooks generally available in the 1990's, the following general classifications were advanced to cover cost and price models of all types. For instance, Ferry and Brandon (1994, p.253) classified models as, '*(i) the function that they perform, (ii) the form of construction they represent, (iii) analogue, and (iv) symbolic models*'. Ashworth (1994, p.110) offered an even more general classification of models in use, namely, '*(i) manual, (ii) computer based, (iii) initial construction costs, or (iv) life cycle and/or total costs in nature*'.

Given the literature reviewed it has become apparent that no consensus existed as to a classification system that could be applied to the building project forecasting models identified from the available literature and presented in Table 2.1 above. The majority of the classification systems that have been advanced have been found to be general in nature and address the characteristics of both cost and price models. This was the situation that Skitmore (1991) found when he reviewed the performance of available price models. Skitmore (1991) pointed out that work done at that time by Skitmore and Patchell (1990), Newton (1991), and Raftery (1991) had analysed the underlying concepts and structures of building price forecasting models and had arrived at different results. Skitmore (1991, p.275) asserted that such results showed '*a lack of theoretical basis and the general need for more work in this area*'.

The literature reviewed has revealed the extent of knowledge already established in relation to this topic. It has indicated that there is a lack of consensus on just what should be an agreed classification system for building project price models. Given the diversity of the potential classification systems identified above and the acknowledged lack of consensus in the literature reviewed above then it seems that this research will have to address the development of an agreed classification system that encompasses all building price forecasting techniques currently in use as one of its sub-aims. To enable such a classification system to be

developed it will be necessary to ground it in the characteristics or factors that affect practitioners when they are deciding which type of building project price forecasting model to use.

As a first step towards the identification of those factors it will be necessary to determine what are the models or tools that are currently available and being used by construction professionals in the field, and then secondly, to identify potential selection factors from the relevant literature available. Therefore it was necessary to review the models listed in Table 2.1 in order to develop a data collection approach that would enable the establishment of the models in actual use to be achieved.

2.5 Summary and reflections on the research process

2.5.1 Summary

Fig. 2.3 illustrates the main steps that have been taken in this chapter to establish the state of existing knowledge in the field of building project price forecasting and to identify research problems addressed in this study.

The chapter started by considering terms in common usage that were related to the topic under consideration. It set out definitions of those terms that it would adopt throughout the study. It was decided that the main thrust of the work was to be concerned with building project price forecasting rather than construction cost modelling. It was made clear that the work was to be centred on issues related to models that represented total prices that individual clients would have to pay to contractors for them to undertake the construction of their proposed building projects. In addition the work intended to consider issues related to building project price forecasting models that were capable of providing project related information in terms of the anticipated total project prices to be paid (macro level) as well as the prices of distinct parts of that total price (micro level).

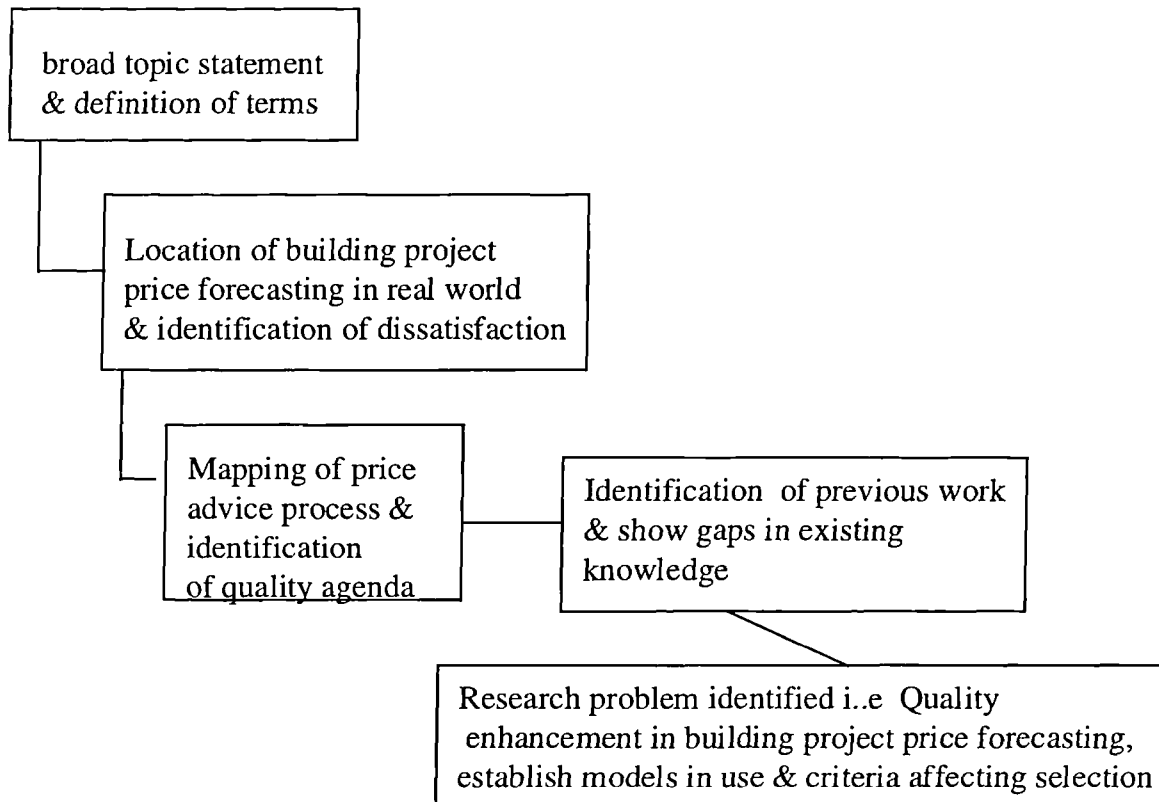


Fig. 2.3 The literature review and research problem identification process

Having defined its terms the chapter then identified its broad topic area in terms of locating it within the setting of real world problems. The context identified for the work was the provision of early stage building project price advice to construction clients who were involved in making value-for-money business decisions. The provision of this service was seen as being a complex, risky, and professional task. Such a task was typically undertaken in England by consultant quantity surveyors. Evidence provided indicated that there was dissatisfaction with the way in which building project price advice had been produced in the past. Therefore it was resolved to examine what consultant quantity surveyors did and how they went about doing it in terms of the provision of building project price forecasting advice in order to discover a 'quality' or 'best practice' approach.

In order to identify a best practice approach it was necessary to break down the processes involved in building project price forecasting. In so doing this study has developed a model of the completed process (see Fig.2.2) which enabled it to locate previous work done in the area and identify the contribution that this study could make to knowledge in the field. This

chapter then considered how quality enhancement, in terms of the building project price advice *process*, rather than just the *product* could be achieved. Research previously undertaken in the area was reviewed and it was concluded that it had been dominated by efforts to improve one criterion, namely accuracy, which was revealed to be a measure of model *product* quality rather than model *process* quality.

The work identified a much broader research agenda on quality enhancement in building project price forecasting and located its contribution within the investigative cycle of the forecast formulation phase of the price advice process.

Literature was then reviewed in order to reveal the state of existing knowledge in the field. The study identified the work that had been undertaken on building project price forecasting in general, and then the investigative cycle of the forecast formulation phase in particular. The review established that a 'hard edged' model centred research paradigm had previously existed but that a 'softer edged' more people-orientated school of research had now become established. The work identified that this study will contribute towards establishing an applications based research theme in the currently re-focused people-orientated school of research. Such an applications based research theme needed to consider a number of factors, one of which revolved around the determination of the forecasting models actually in use by the practitioners concerned.

Key literature was then identified and analysed in order to develop a taxonomy of potential building project price forecasting models which were presented in Table 2.1. In order to facilitate the determination of which models were in current use it was necessary to group them together into an agreed classification system. After considering the classification systems available it was discovered that the subject area lacked an agreed classification system and it was resolved to develop an applications based classification system which would be grounded in practitioner experience.

2.5.2 Reflections on the research process

The size of the task involved in obtaining and reviewing the large volume of literature published in this subject area over the last twenty years was a task that was initially underestimated in terms of effort and time required. The literature review was undertaken on an on-going basis that started when the study commenced in September 1994 and continued until the writing up process commenced in September 1998. However, at critical points during the study, for instance, during the preparation and distribution of the nation-wide survey during the autumn of 1996, it was found necessary to act on the literature as it was then available and reviewed at that time.

What has been noticeable over the period of the study has been the pace of technological advance in terms of information retrieval. The wider access to and the development of the internet made the task of documentation retrieval far less demanding in 1998 than it was in 1994, when the study started.

The evaluation of the material published by 'key players' who were still active in the field, such as Akintoye, Ashworth, Bowen, Raftery, and Skitmore was greatly facilitated by attending national and international conferences with them on a regular basis throughout the life span of the study. Part of the literature review and the case for the study was presented at a CIB W55 symposium in Zagreb in 1996 and at the 1997 Annual ARCOM conference at Kings College Cambridge. The experience and feedback from other researchers in the field provided by such opportunities proved invaluable.

The adoption of good basic research skills, such as the rigorous filing and annotation of materials which could potentially become quotations within the body of the work was a skill which was continually developed throughout the study and one which was particularly exercised in the writing of this chapter.

The compilation of a literature review that is focused and presented in a logical yet interesting format, that uses language which is precise yet informative, and which manages to keep the central research problems of the study at the centre of its main

thrust has been an 'ideal' that I have striven for. I have noted that the development of actual personal competence in the compilation of such an 'idealised' literature review is an activity, like many others, which needs several iterations before a practitioner can claim to have reached any measure of competence.

2.7 References

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Chapter 3

THE IDENTIFICATION OF BUILDING PROJECT PRICE FORECASTING MODELS IN ACTUAL USE

3.1 Introduction

The parameters of the research agenda on quality enhancement in building project price forecasting were established as a result of the literature reviewed in chapter 2. That review enabled the major research problems for this study to emerge. In particular, gaps were identified in what was generally known about how consultant quantity surveyors undertook the process of formulating building project price forecasts. It was resolved to explore those gaps in terms of the building project price forecasting model selection process in order to discover the factors that influence construction professionals in their selection of price forecasting models for use. Such an exploration would in turn enable the development of a conceptualised model of the processes involved.

It was realised that in order to develop a conceptualised model of the process it would be necessary, firstly, to map out the current state of the art in terms of building project price forecasting models in actual use. Then secondly, to explore and interpret the building project price forecasting process in-depth so as to develop an understanding of how construction professionals evaluated competing factors in the price forecasting model selection process.

This chapter discusses the methods used to map out the current state of the art. Initially it considers differing research methodologies that could have been used to resolve the problems identified above. It then provides a justification of the quantitative approach adopted in this chapter and an account of the development of an appropriate measuring instrument. The chapter then details the measures that have been taken to collect data, including, the piloting of the questionnaire, its issue, and follow-up procedures. The main findings of the survey are then summarised in order to facilitate their later statistical analysis. The chapter concludes with a reflection on what has been learned as a result of the research so far undertaken.

The first step in the mapping out of the current state of the art, in terms of building project price forecasting, was to consider the overall design of the research process itself. Such a consideration would allow the most appropriate of the available research methodologies to be determined.

3.2 Research Methodology

Fellows and Liu (1997, p.21) defined research methodology as being '*the principles and procedures or logical thought processes which could be applied to a scientific investigation*'. Given the research problems identified above it was apparent that this investigation needed to have its methodology set out in terms of an overall research design. Such a design would have to allow for the work to develop an understanding of the building project price forecasting process in general, as well as the model selection process in particular.

Hakim (1987,p.1) commented that a good research design '*dealt with aims, purposes, intentions, and plans, within the practical constraints of location, time, money, availability of staff.... and it also identified a personal style*'. The limited resources available, in terms of money and administrative support for the work, were real issues found at the outset of the study which affected the determination of a suitable approach. More fundamental was the development of a '*personal style*' or philosophy of approach to the research process itself. The establishment of a personal research paradigm needed to take into account the differing philosophical outlooks available. Raftery *et al* (1998, p.294) identified what they termed as being two opposing research philosophies, namely, '*rationalism and interpretivism*'.

Standard textbooks on research methodology such as those by, Allen and Skinner (1991), Robson (1993), and Fellows and Liu (1997), as well as refereed journal papers by academics such as Runneson (1997), and Seymour and Rooke (1997) have identified the quantitative (rationalist) and qualitative (interpretivist) research paradigms as being opposed to each other in philosophy and approach. The sources indicated above have each advocated the adoption of either the quantitative or the qualitative research paradigm as being the only valid approach to take in research design.

Bryman (1996, p.140) summarised the differences between the two differing research paradigms in terms of their respective perspectives as being '*qualitative research presents a view of the process whereas quantitative research provides a statistical account of the product*'. Researchers that favour the quantitative approach look to test theories and concepts by collecting data, often from surveys, that could be subjected to statistical analysis. Bryman (1996, p.104) suggested that such data tended to be only '*superficial in nature*', and often reflected the desire of the researcher to follow the accepted scientific principles of positivism and rationalism.

Researchers that favour the qualitative approach reject the formulation of theories and concepts in advance of their data collection in order to gain a greater understanding of the process under investigation. Bryman (1996, p.61) asserted that such an approach reflected Weber's idea of '*verstehen*' or understanding by seeking to gain '*a view of events, actions, norms, and values from the perspective of the people involved in the process*'. This interpretivist view of research has often been accused of being unscientific and biased in its approach and therefore incapable of producing generalisable results.

Sources such as Seymour and Rooke (1997) or Runneson (1997) have argued for the adoption of either the quantitative or the qualitative research paradigm as being the only approach to adopt due to what Bryman (1996,p.50) referred to as their '*inter-related set of assumptions about the social world in terms of philosophy, ideology, and epistemology*'. Creswell (1994, p.4) summarised the differences between the quantitative and qualitative research paradigms in terms of their respective positions on '*ontological, epistemological, rhetorical, and methodological*' grounds.

Creswell (1996, p.15) went on to suggest that adherents to the two differing research paradigms see the nature of reality (ontology) from differing perspectives which cause differing approaches to the relationship between the researched and the researcher (epistemology) to be adopted. In addition, Creswell (1994) asserted that researchers who adhered exclusively to one paradigm or the other made differing uses of language and words (rhetorical assumptions) which caused them to adopt differing approaches to the actual process of the research itself (methodological assumptions).

Creswell (1994, p.15) also asserted that the criteria that could be used to select between the differing research paradigms were related to fundamental issues within the individual researcher. Creswell suggested that researchers bring with them their own '*worldview or assumptions on each paradigm*' which has been formed by their training, experience, and psychological attributes. Such a combination of factors within an individual inevitably form an overarching approach to research and problem solving in general.

Another more pragmatic approach was advocated by Robson (1993, p.38) who indicated that in general the principle to adopt was that '*the research strategy and the methods or data collection techniques employed, must be appropriate for the questions that needed to be answered*'. This real world view was reinforced by Chau *et al* (1998, p.99) who suggested that, since construction management was a practical subject, the choice of research approach should also be a '*pragmatic*' one.

This pragmatic approach to research and problem solving, which sought to take advantage of the strengths of both paradigms, was the approach adopted in this study. Raftery *et al* (1998,p.295) quoted Csete and Albrecht (1994) in their justification of such a pragmatic approach to research methodology in construction management research in general as,

'both paradigms ascribe to the same basic goal of research, namely, to gain a better understanding of the world, and both attempt to demonstrate in different ways the trustworthiness of their findings by striving for truth, consistency, applicability, and neutrality in the application of the actual research methods used'.

Such a pragmatic approach to problem solving matched the investigators 'personal style or philosophy'. The major research problems identified above asked questions of '*what*' and '*how many*', as well as '*how*' and '*why*' and so required a combination of quantitative and qualitative approaches to be adopted.

Bryman (1996, p.137) cited the use of what he termed to be a '*mixed research design*' that was adopted by Kahl (1953). In that study a large scale questionnaire survey on the career aspirations of working class schoolboys in America was undertaken. That work preceded a

follow-on qualitative investigation with a much smaller number of participants that were identified from the initial survey's respondents. That study was designed to identify and weight influential factors that were thought to affect career path selection. Bryman reported that in Kahl's research

'the initial quantitative research allowed a mapping out of the issues to be addressed which in turn also allowed a basis to be formed for the selection of comparison groups of participants for further in-depth qualitative interviewing'

This latter combined approach reflected the issues at the core of this study. For instance, this work needed to map the existing state of the art in terms of building project price forecasting models actually in use before it could identify issues that were causing practitioners to select particular models for use. Thus this study needed to adopt a mixed or combined research design that allowed quantitative data to be collected on models in-use before more in-depth qualitative data could be obtained from practitioners in the field on price forecasting model selection criteria.

With this in mind it was noted that Creswell (1994, p.184) had identified that there were three different approaches that could be adopted within such a combined research design, namely, *'a two-phase design, a dominant-less dominant design, and a mixed-methodological design'*. Creswell (1994, p.185) cited a study by Kushman (1992) in which school teacher commitment was investigated. The research design adopted was what Creswell labeled as being a *'two-phase design'*. Phase one was a quantitative study that looked at *'statistical relationships between teacher commitment and differing organisational factors'*. Phase two adopted a qualitative approach to look at individual teachers within specific schools in order *'to better understand the dynamics affecting school teacher commitment'*.

Kushman's research reflected similar issues being considered in this study. For instance, this study needed to identify the effect of organisational factors on building project price forecasting models in-use before it could unravel the dynamics of the practitioner model selection process.

Therefore it was decided to consider the use of a two-phased combined research design for this study.

It was acknowledged that the adoption of such a two-phased combined research design for the study would have real resource implications. It was recognised that such issues needed to be addressed prior to work being undertaken. In particular, it was recognised that the first phase of the work, which called for a quantitative investigation, would require additional administrative support to process the survey data generated. It was also anticipated that the second phase of the work, which required contact with professionals in the field, could only be achieved with assistance from an external source of funding. With this in mind bids were made for internal institution research funding for administrative support, in terms of data processing, and externally, to the RICS Educational Trust, for funding to execute phase two of the research design.

Both bids were supported and so it was resolved to adopt the two-phased combined research design for the work as outlined above.

The two-phase combined research design actually adopted in the study facilitated what Fellows and Liu (1997, p.9) termed as a '*triangulation of quantitative and qualitative techniques*'. Creswell (1994, p.182) went further and asserted that such methodological triangulation could be considered to be '*sequential in nature*' in that '*the results of the first phase provide the framework for the investigations in the second phase*'.

The two-phased combined research methodology reflected what Raftery *et al* (1998, p. 295) termed as being '*a sensible pragmatic approach*', that has made use of research methods that '*were appropriate to the tasks in hand*'. Such an approach was also advocated by DeVaus (1996, p.356) who asserted that '*methodological pluralism was the desirable position to adopt, as the method used should suit the research problem to be investigated rather than the problem fitted to a set method*'. Such an approach for this study also ensured that the inferences drawn from the study have added to the existing knowledge on the topic.

The first phase of the methodology called for a quantitative investigation into the building project price forecasting models actually in-use. This stage of the work would enable the existing state of the art to be mapped out. The quantitative research paradigm adopted for this phase of the investigation required the collection of data from practitioners in the field. Bryman (1996, p.12) suggested that the following were the main approaches that could be adopted in a quantitative investigation, namely, '*surveys, experiments, and case studies*'.

Robson (1993, p.43) pointed out that the experimental and case study approaches to a quantitative investigation were appropriate when answers were needed to research questions that asked about *how and why* but were not successful at answering research questions that asked about *what and how many*. Robson (1993) went on to assert that the use of a survey in a quantitative investigation most often enabled data to be collected that answered research questions related to *what and how many*.

Phase one of this study aimed at establishing 'what' building project price forecasting models were in use and 'how many' times they were used by construction professionals in the field. Bryman (1996, p.11) summarised the main advantages of using a survey as being,

'capacity for generating quantifiable data on large numbers of people who were known to be representative of a wider population in order to test hypotheses has been viewed by many practitioners as capturing many of the ingredients of science'.

Therefore a survey was the approach to data collection that was adopted within the quantitative study undertaken in phase one of this work. Nachmias and Nachmias (1976, p.101) identified three main methods of survey research, namely, '*face-to-face interviews, mailed questionnaires, and telephone surveys*'. Given the advances in technology that have occurred since Nachmias and Nachmias' publication a further method, namely, e-mail, was also considered as a means by which quantifiable data from a large number of respondents could be collected. However, an e-mailed survey was discounted, in terms of this study, on the grounds that it would introduce a serious bias in the results obtained, as at the time of the study, namely, 1996/7, not all of the intended survey's population, namely, quantity surveying organisations in England, had access to the internet.

Robson (1993, p.128) tabulated the main advantages and disadvantages of the differing methods of survey research. Given the aims of the work and the resources available the most compelling of the points made by Robson was that *'postal surveys were extremely efficient at providing large amounts of data at relatively low resource costs, in a short period of time'*. In deciding to use the mailed survey approach to data collection within the quantitative phase of the study it was recognised that specific steps would have to be adopted to combat the acknowledged weaknesses of such survey research in terms of, representativeness of sample, low response rates, and uncertain respondent quality.

The first steps in the collection of such survey data was the determination of both an appropriate survey population and an appropriate measuring instrument.

3.3 Survey population and measuring instrument development

The literature reviewed in chapter 2 revealed the theoretical existence of some thirty-two models that were suspected as being available for use by price forecasting practitioners. The models and the sources from which they were identified were illustrated in Table 2.1. Given the research problems identified above and the research methodology adopted it was apparent that the data collected via the mailed questionnaire form had to be given a focus that would allow it to identify individual models that were being actually used to forecast initial building project prices for clients.

Such a focus was provided by Fortune and Lees (1996) who had undertaken a large scale postal survey with over six hundred organisations that were based in the northern region of England in 1993. All respondents to that survey said that they were involved with the provision of early stage building project cost advice for clients. The survey attracted a high response rate of 61%. An analysis of the results indicated that in the context of providing initial building project price forecasts for clients, then the following traditional type of price forecasting models were in widespread use;

'(1) judgement without quantification, (2) the functional unit, (3) the superficial method, (4) the principal item method, (5) the interpolation method, (6) the elemental analysis technique, (7) the significant items method, (8) approximate quantities method, and (9) the detailed quantities method'.

The following newer mathematical or computer-based techniques were also found to be in use but were not as popular as those listed above,

'(10) regression analysis, (11) time series models, (12) causal cost models, - statistical models, (13) ELSIE, and (14) other knowledge based models, (15) net present value, (16) payback method, (17) the discounted cash flow methods - life cycle models, (18) resource based techniques, (19) process based methods, (20) the construction cost simulator - contractors models, (21) the monte- carlo simulation technique, and (22) value management techniques'.

The data gathered in the 1993 survey had addressed many of the issues related to the research questions identified for phase one of this study. However, it was decided to initiate a further empirical study of building project price forecasting models in-use following consideration of the limitations of the 1993 study, which were,

- (i) **Biased sample frame** - Fortune and Lees' (1996) previous work was not considered to have completely identified or accurately measured the popularity of all the individual building project price forecasting models that were then currently in-use due to the potential for regional bias within its sample frame. This bias was acknowledged by Fortune and Lees (1996, p.41) when they said in their criticisms of that study,

'the actual sample that was established could be flawed due to potential bias in its geographic location. The study was based on the north of England and north Wales, and although large in size, did not obtain data from across the UK'.

- (ii) **Location of "leading edge" organisations** - It was suspected that there would be a greater propensity to use the newer computer-based models in London and the south-east of England due to the potential for 'leading-edge' quantity surveying organisations and the head offices of nation-wide quantity surveying organisations to be based in such geographic locations.

- (iii) **Incomplete results** - Fortune and Lees (1996, p.40) acknowledged that there were some models in-use in 1993 that had not been identified by the survey, in particular they commented that

'the survey showed that the final form did not fully identify all the risk analysis, knowledge based, and value related models currently used by practitioners'.

As these were some of the newer non-traditional types of building project price forecasting models thought to be available it was felt important to try and capture more data on their actual identity and the extent of their use in practice.

Given the limitations with the existing work indicated above it was resolved to repeat the survey research on a nation-wide basis. This approach enabled the study to determine whether Brandon's (1982) paradigm shift away from traditional deterministic building project price forecasting models had now been effected by practitioner organisations operating across England.

In addition, the proposed nation-wide investigation was also designed to be a repeated survey, as defined by Firebaugh (1997). The repeated aspect of the survey affected those quantity surveying organisations that were based in the northern region of England and who were registered with the RICS both in 1993 and in 1997. The study was also designed as a support protocol for the collection of what would become trend data given further repetitions of the survey with the same population in the future. Such data would provide evidence of movement in terms of models in-use and which, over time, would effectively monitor change in professional practice.

A further justification for the repetition the 1993 survey on a nation-wide basis was the potential for it to generate participants from which further data could be collected. This was a necessary step in order for the two-phase combined research design to be accomplished. Kahl's (1953) work, as identified in Bryman (1996), indicated that such a design called for the identification and selection of a number of appropriate participants in order to explore, interpret, and model the building project price forecasting process. Such an approach to participant selection would minimise bias and provide answers to the questions related to 'how' and 'why' particular building project price forecasting models were selected for use. This qualitative approach was what was called for in phase two of the research design.

The collection of survey data within a quantitative study usually calls for a sample of potential respondents to be determined from the population being surveyed. Normally, it was necessary to ensure that the sample of proposed respondents was as representative as possible of the population being surveyed in order to ensure that the results of the research were capable of being generalised.

Fowler (1993, p7) asserted that in order to produce results that could be generalised then the following were the critical issues that needed to be addressed, namely, '*(i) the choice of whether or not to use a probability sample, (ii) the sample frame (iii) the size of the sample, (iv) the sample design*'. Sapsford and Jupp (1996, p.31) identified the different ways in which a probability sample could be designed in order for it to represent a known population, namely '*the systematic sample, the stratified random sample, the cluster sample, and the quota sample*' .

The population being surveyed in this study were organisations that provided a building project price forecasting service to clients. The literature reviewed in chapter 2 indicated that in England such a service was provided by organisations listed by the RICS. The population that needed to be surveyed in order to determine which forecasting models were in use comprised the two thousand three hundred and twenty seven organisations that were listed by the RICS as being approved organisations in England in 1997. The RICS were approached and it agreed to provide a complete mailing list of such approved organisations.

However, the RICS were unable to provide any information about the types of organisations, the size of organisations, and the extent of computing facilities within the organisations that made up their membership list. These were issues that were raised as potentially influential factors in the use of particular types of price forecasting model in the literature reviewed in chapter 2. As the RICS were unable to provide any information on their membership that addressed such issues it was not possible to determine a randomised probability sample. In addition, a further aim of this first phase of the study was to generate as many potential participants as possible for the more in-depth qualitative second phase of the work.

Accordingly it was resolved to undertake a full population survey of **all** RICS listed quantity surveying organisations listed as operating in England in 1997. It was acknowledged that although such an approach to the survey would avoid any potential bias due to sample size or selection, there would be the potential for what Sapsford and Jupp (1996, p.28) termed as '*non-sampling error*'. Such errors or bias could result from poor administration of the survey forms themselves or the computerised data it generated.

Having determined 'who' should be subjected to the survey it was then necessary to determine the extent and scope of the data to be collected by designing an appropriate questionnaire form.

Questionnaire Form Design

The individual building project price forecasting models listed on the questionnaire form that was used for the 1993 regional survey had been grouped for convenience of data handling within the classification framework set out by Raftery (1991). The literature reviewed in chapter 2 had indicated that there was no consensus as to the most appropriate classification framework for the building project price forecasting models in actual use. It was resolved to adopt as a sub-aim of this work the development of an applications based classification framework that was grounded in practitioners' experience. Accordingly, it was decided that neither the grouping of the individual models nor the actual group labels applied to them on the survey form itself would bias the results obtained, in terms of the subsequent applications based classification framework.

However, the following models were identified from the literature and listed in Table 2.1 but were *not* identified by Fortune and Lees (1996) as being in current use in 1993, namely,

'the conference method, comparison method, cubic method, storey- enclosure method, graphical, superficial perimeter, exponent, financial method, dynamic programming, linear programming'.

The issue of which models to be included on the finalised questionnaire form was clearly a matter that needed to be addressed during the piloting stage in the development of an appropriate measuring instrument for the study. One of the limitations of the 1993 study was that it had not identified all the models in current use. Given the additional building project price forecasting models identified in the literature reviewed in Chapter 2 it was resolved to include an additional 'open-ended' question on the questionnaire form that asked respondents to specifically name any additional models that they used but which were not named on the questionnaire form itself.

The two-phased combined research design settled on for this study called for the quantitative investigation (phase one) to facilitate the identification of potential participants for the later qualitative study (phase two) of the work. Therefore it was resolved to include a further

'open-ended' question on the survey form that invited respondents to nominate either themselves or a colleague with whom contact regarding further work could be made

It was therefore resolved that the model groups and individual techniques or tools that were listed on the survey form (copy in appendix 1) were included as indicated below, namely,

- (1) **Traditional** - judgement, functional unit, cost per m², principal item, interpolation, elemental analysis, significant items, approximate quantities, detailed quantities.
- (2) **Statistical Techniques** - regression analysis, time series models, causal cost models.
- (3) **Knowledge Based Systems** - ELSIE system
- (4) **Life Cycle Costing Techniques** - net present value, payback method, discounted cash-flow.
- (5) **Resource/Process Based Techniques** - resource based, process based, construction cost simulator.
- (6) **Risk Analysis Techniques** - monte-carlo simulation, other risk models
- (7) **Other** - value management

It was decided to include value management as an additional building project price forecasting technique or tool on the questionnaire even though it was an approach which, if adopted in practice, resulted in other traditional and non-traditional models being called into use. It was decided to collect data on the incidence in-use of value management as such data would provide additional evidence with which to judge the extent of any paradigm shift in the provision of building project price forecasting advice in England in 1997.

3.4 Data collection procedures

To ensure reliability in the results of the survey it was necessary to achieve a high response rate. This would allow the results to be generalised to the population and also mitigate the acknowledged disadvantages involved with this method of collecting data, namely, uncertain respondent quality, the potential for mis-interpretation, and the inability to supplement respondents answers with observational or additional data. Issues affecting response rates could be addressed by considering the design of the questionnaire form itself and the procedures associated with its administration to the survey population.

Hoinville and Jowell (1978, p129) suggested that the following points of self completed postal questionnaire design have been shown to ensure high response rates, namely,

'(i) attractive presentation, (ii) respondents asked to tick boxes rather than add information, (iii) long questionnaires make use of sub-lettering within question numbers, (iv) instructions for completion were explicit, (v) more difficult questions were presented towards the middle and end of the questionnaire form, (vi) wording used for each question was explicit, and (vii) any additional information and/or cover letter were presented in a clear, concise manner'.

Issues related to these points were considered as part of the initial drafting of the questionnaire form. The form itself had been effectively piloted as far as this study was concerned as it had been used as the basis for a regional survey in 1993. That survey had attracted a 61% response rate and so the issues referred to above by Hoinville and Jowell (1978) could be considered as being satisfactorily resolved

Hoinville and Jowell (1978, p.131) also suggested that unsolicited mailed surveys could, on occasions, attract a 70% response rate but that it was more normal to attract around a 50 % response rate. The achievement of even this level of response was, according to Hoinville and Jowell (1978, p.131), helped by paying particular attention to *'the initial mailing, the cover letter, the reminder, and follow-up procedures, and the use of incentives'*. Given the resources available for the execution of this study it was not possible to consider the use of incentives as a means of minimising the survey non-response rates.

Fowler (1993, p.38) identified that non-response to mailed surveys could also be due to *'(i) the data collection procedures not reaching the selected individual, (ii) the individual refusing to respond, and (iii) the individual contacted being unable to provide the data requested'*. The high response rate achieved by the 1993 regional survey indicated that these concerns had been addressed in a satisfactory manner. Linksy (1975) reviewed other issues thought to affect response rates, such as those related to paper colour, date and day of issue, and the use of postage paid or stamped addressed envelopes. It was resolved to print the questionnaire form on different coloured paper from the cover letter and internal institutional resources permitted the use of standard pre-franked return envelopes. All questionnaires were addressed personally to the senior partner or managing director of each organisation contacted.

Given the sources indicated above it was clear that the maximisation of the survey's response rates would be achieved by giving particular attention to the pre-test and piloting process as well as the actual procedures adopted for the survey's issue and follow-up activities.

3.4.1 Pre-test and piloting

DeVaus (1996, p.100) identified that a rigorous piloting process was an important step in ensuring a high response rate to a mailed questionnaire. It was suggested that the following issues should be given particular attention '*variation of responses, question understanding by respondents, question redundancy, potential for non-response, length of questionnaire, number of questions, and the time taken for response*'.

The pre-test was carried out with three professionally qualified academic colleagues who had previously practised as building project price forecasters. As a result of this pre-test it was discovered that although the proposed questionnaire form itself was appropriate, there were further alterations required to, (i) the layout of the sheet asking for further supplementary information and (ii) the clarity of the contents of the cover letter. Therefore, the draft questionnaire form and its cover letter were altered to what can be seen in appendix 1

The length of time taken to respond to the form by the subjects in the pre-test study was between ten and twenty minutes. This timescale appeared to be a reasonable period within which it could be expected that construction professionals in the field would have available to respond. It was felt that a further pilot study should be undertaken with the revised questionnaire form and its cover letter with a subject group similar to the survey population.

Therefore, a revised questionnaire form together with an explanatory letter was sent by mail to a sample of ten quantity surveying organisations. The subjects for this pilot study were selected to reflect a reasonable mix of organisational types anticipated as being within the survey population for the main study. This pilot study achieved a (60%) return rate within two weeks of the questionnaire forms being issued. Each respondent returned a feedback questionnaire form on the revised pilot questionnaire form itself and this indicated that the form could be completed within a fifteen to twenty minute period.

The responses obtained from the subjects in the pilot study indicated a satisfactory spread of responses across each of the individual questions within the questionnaire form itself. There were no responses to the additional questions on additional forecasting models in-use and willingness to contribute further to the work, that had been inserted into the draft 1993 form. In addition there appeared to be no redundant questions and the feedback sheets showed respondents understood each of the questions asked. The only amendment made to the main study questionnaire form as a result of this piloting exercise was the repetition of the instructions regarding model scoring criteria, i.e. 1 (low) through to 4 (high) on each page of the questionnaire form itself.

The speed of response and high return rates of the draft measuring instrument used in this pilot study confirmed that this self-administered postal questionnaire was capable of generating sufficient data that could be analysed. Therefore, it was resolved to amend the revised questionnaire form as indicated above and proceed with the main study.

3.4.2 Issue and follow-up procedures

As indicated above, the risk of biased sample selection was dealt with in the survey by including all the population of quantity surveying organisations listed by the Royal Institution of Chartered Surveyors as operating in England in 1997. A final total of 2327 separate organisations were included as subjects within the survey frame. For the purposes of this study an organisation was defined as '*a separately listed company/practice or separately listed part of a company/practice with its own business address*'. This definition was included within the 'notes for guidance' section of the mailed questionnaire form. Given that the study was also designed to support a within-sample repeated-questionnaire analysis, it was necessary to identify part of the overall sample as being located in the north of England. In keeping with Fortune and Lees' 1993 survey, all organisations included in the sample that were located in the following counties were deemed to represent the north of England for analysis purposes, namely,

Northumberland, Cumbria, Yorkshire, Humberside, Lancashire, Greater Manchester, Merseyside, Cheshire, Staffordshire, Derbyshire and Nottinghamshire.

Questionnaire forms sent to organisations located in such counties were produced on different coloured paper and were coded separately in order to facilitate later analysis and reduce the potential for non-sampling error.

The follow-up procedures advocated by Scott (1961), Moser and Kalton (1971), and Hoinville and Jowell (1978) were adopted in order to maximise the potential return rates. In particular, it was resolved to allocate a unique reference number on the stamped and addressed return envelope provided for each organisation included within the sample frame. The sources identified above indicated that it was advisable to place reference numbers on all documents to be returned from the survey respondents. However, given the size of the survey and the resources available it was decided to restrict the placement of the respondent reference number to the return envelope only. In so doing it was possible to identify the non-responding organisations so that they could be contacted again should any necessary follow-up procedures prove to be necessary.

65% of the responses to this initial postal survey were returned within two weeks of the initial mailing and this confirmed suggestions on speed of survey response rates made by Scott (1961). However, the overall response rate to the initial mailing of this survey was only 25.05%. Moser and Kalton indicated that the results of a postal survey could be considered as biased and of little value if the response rate was lower than 30%–40%. Therefore it was resolved to activate Scott's (1961) follow-up procedures in order to increase the rate of return. Each non-responding organisation was contacted again four weeks after the initial mailing was dispatched with a reminder note and a further copy of the survey form. The second mailing achieved an additional response of 29.9% and so increased the overall response rate to 47.5%.

As one of the stated aims of the investigation was to try and obtain data from as many separate organisations as possible, it was resolved to send out a further mailing to those organisations that had not as yet responded to either of the previous invitations to respond to the survey.

Sieber (1992) identified a range of ways to collect data that would correct for non-response to initial mailings, namely by, (i) identifying proxy respondents, (ii) executing statistical adjustments or (iii), by re-surveying a sample of non-respondents. Of the techniques identified it was resolved to adopt (iii), i.e. re-survey a sample of non-respondents. Accordingly, a fifty per-cent random sample of all non-respondent organisations was established and re-contacted with a further letter of encouragement to participate, and a further copy of the questionnaire.

Sieber (1992) also established that if the new round replicated the measuring instrument then the results could be added to the initial sample data set. A third mailing was dispatched to the sample established and attracted a 31.11% response rate. This procedure lifted the overall response to 55.7% of the original sample frame of quantity surveying organisations in England. Hoinville and Jowell (1978, p.142) suggested that in postal surveys '*two reminders would suffice to produce an acceptable response rate of 60% plus*'. So the results achieved in this survey were broadly in line with the response rates suggested as being acceptable in the sources identified.

Seiber (1992) also indicated that the data from the third round of mailings could be weighted to adjust for the fact that only a sample of the total non-respondents received the further follow-up treatment. Applying Seiber's (1992, p.142) principle, which stated '*that if half the non-respondents were followed-up then the respondents from that phase of data collection should be weighted by a factor of two*' when they were combined with the initial data, then the overall adjusted response rate from the 2327 separate quantity surveying organisations listed in the original subject frame could be said to be 63.9%.

Table 3.1 summarises the number of questionnaires sent and received from 'each mailing' on both a nation-wide and regional basis. Given that the study had no administrative support for this aspect of the quantitative investigation it was necessary to send the questionnaire out in stages between January 1997 and May 1997. The survey was mailed initially to organisations located in the north of England in order to facilitate direct comparison with the 1993 regional survey with the same population.

Table 3.1 Survey Response Rates

	Sent (All)	Return (All)	Response %	Sent (North)	Return (North)	Response O/all %
Mail 1	2327	583	25.05	695	162	23.31
Mail 2	1749	522	29.85	533	204	38.27
Mail 3	614	191	31.11	165	45	27.27
Totals	2327	1296	55.69	695	411	59.14

3.5 Survey Results

3.5.1 Generally

The mailed questionnaire form, cover letter, and stamped addressed return envelope used in the main survey can be viewed in appendix 1. The questionnaire form itself had a total of seven separate questions and in the '*notes for guidance*' section each participant was asked to respond to each question by circling the most appropriate option listed. The mailed questionnaire used in the survey was developed with the specific aim of making responding as easy as possible. Accordingly respondents were asked to circle the most appropriate response from the options listed. In addition definitions of terms such as '*organisation*' and '*early cost advice*' were supplied to avoid misunderstanding. Early cost advice was defined for the purpose of this study as being '*any cost advice given to the client prior to a formal offer to contract being made*'.

A total of 1296 (55.7%) organisations responded to the survey. The results for each of the main questions are presented below.

3.5.2 Type of organisation - question 1

Each respondent was asked to classify their own organisational type, the responses to which can be seen in Table 3.2. The respondents to this question were asked to indicate which one of the eleven organisational types listed they would classify their own organisation into. In addition a further option was included that was styled '*none of these*' should any respondent find that they were unable to classify their type of organisation within the eleven options

listed. This question ensured that the classification of respondents' organisation type was not biased as each respondent determined their own most appropriate category.

The responses to this question would also allow statistical trends related to organisational types to be identified in the subsequent analysis of the data generated. The distribution of the responses to this question can be seen in Table 3.2. Some 90.4% of respondents to the survey made a response to this question.

The three most popular types of organisation who responded to question 1 on the survey form accounted for 90.5% of all respondents to the question. The most popular organisational types were; quantity surveying practices (70.9%), multi-disciplinary practices (10.1%) and organisations that styled themselves as project management consultants (9.4%). Some organisational types such as architectural practices (0.54%), management contracting (0.90%), design and build contracting (0.45%), specialist contracting (0.09%), and civil engineering practices (0.18%), when added together attracted less than 1% of the responses to this question.

Table 3.2 Distribution of types of organisation responding to Question 1

Type of Organisation	Nr of Responses	% of Total Responses
Quantity surveying practice	793	70.99
Multi-disciplinary practice	113	10.12
Architectural practice	6	0.54
Consulting engineers practice	0	0
Local or public authority	32	2.86
General contracting	15	1.34
Management contracting	10	0.90
Design and build contracting	5	0.45
Specialist contracting	1	0.09
Project management	105	9.40
Civil engineering	2	0.18
None of these	35	3.13
Total	1117	100.00
Did not respond to question	119	

The results indicated that the categories of organisational type suggested on the questionnaire form were appropriate for the population surveyed. It was shown that only 3.3% of respondents were unable to classify themselves under one of the organisational types suggested and only one category, namely, consulting engineers, failed to attract any respondents.

3.5.3 Computing facilities - question 2

This question asked respondents to identify the computer facilities that were available to staff involved in the preparation of strategic cost advice for clients. A simple question that asked each respondent to indicate whether computers were available to them in the workplace was discounted as this would have collected data that would not have provided any information on the quality of the provision available. It was thought that the actual availability of computers to each member of staff involved in the formulation of building project price advice to clients would be a factor in determining which model was selected for use. Therefore the question that was asked required each respondent to assess the ratio of computer workstations to staff within their organisation. Five options were listed on the survey form that ranged from '*1 staff to 1 workstation*' to '*none available*'.

Table 3.3 Computing facility of organisations responding to Question 2

Computer Facility	Nr Responses	% of Respondents
1 staff to 1 workstation	523	47.29
2 staff to 1 workstation	328	29.66
3 staff to 1 workstation	123	11.12
>3 staff to 1 workstation	63	5.70
No facility at all	69	6.24
Total	1106	100.00
Did not respond to the question	130	

The results of this question have been set out in Table 3.3. The responses to this question enabled trends and biases in terms of the effect of computing facility and use of individual models to be determined following statistical analysis of the data. Some 89.4% of respondents to the survey made a response to this question.

The results showed that the majority (47.3%) of organisations responding to this question had a ratio of staff to workstation of 1 to 1. When the (29.7%) of respondents who indicated that they had a 2:1 ratio were added to these initial figures then it revealed that a clear majority (77.0%) of all respondents to this question had ratios of staff to workstations of 2:1 or better.

Only (6.2%) of organisations that responded to this question indicated that they had no computer facilities at all. However, a further (5.7%) indicated that they had ratios of staff to workstation of more than 3:1 which made more marginal the actual availability of computing facilities to the individual staff members concerned.

3.5.4 Price advice provision - question 3

This question asked respondents to state whether their organisation was in fact involved in preparing strategic building project price advice to clients. If an organisation was unable to respond positively to this question then it was advised to answer no more questions and return the part of the questionnaire form that was completed to the sender. This question provided an early exit for those organisations that had been included in the survey but did not provide the type of services to clients that were the subject of the survey. The question was placed after the initial questions on organisational type and computing facility on the questionnaire form in order to gather data that was thought to be of use to the survey in general.

The results of this question on the questionnaire form have been set out in Table 3.4. The results have shown that 90.4% of organisations who responded to the survey answered this question.

The results from this question have shown that 91.3% of respondents did provide building project price advice to clients. This result has indicated that the subject frame for the survey was appropriate and it has reinforced the relevance of the responses received.

Table 3.4 Building project price advice provision and organisations responding to question 3

Early advice provision	Nr of responses	% of respondents
Yes	1020	91.32
No	97	8.68
Total	1117	100.00
No response to question	119	

Question 4 on the survey form was divided into two parts. Part A asked each of the respondents to enumerate the number of staff actively involved in the early advice function. Part B asked respondents to assess the proportion of the building project price advice function that was undertaken by staff at trainee, surveyor, and senior surveyor or partner/director level.

3.5.5 Size of organisations - question 4 (a)

The results from this question would enable the investigation of potential relationships between organisational size and use of particular building project price advice models. The question was designed in order to allow organisations to differentiate between staff that they employed in total and staff that were utilised in the building project price advice function.

As there was no previous information available as to the potential size of organisations involved in building project price advice provision, in terms of the actual numbers of staff involved, it was decided not to include predetermined size categories on the survey form. Rather, each respondent was invited to enter the actual number of staff involved in the

building project price advice function within their organisation. The results of this question have shown that 70.8% of respondents to the survey answered this question.

Table 3.5 Size of organisations responding to question 4 (a)

Size of Organisation Nr of staff involved with strategic advice	Nr of Responses	% of Respondents
1	226	25.83
2	153	17.49
3	110	12.57
4	87	9.94
5	50	5.71
6	56	6.40
7	12	1.37
8	32	3.66
9	7	0.80
10	46	5.66
11	4	0.46
12	12	1.48
14	4	0.46
15	10	1.25
16	1	0.11
17	2	0.23
18	2	0.23
20	16	1.96
25	8	0.88
30	5	0.57
33	1	0.11
35	1	0.11
40	6	0.69
50	5	0.57
60	1	0.11
70	1	0.11
80	5	0.57
90	2	0.23
100	5	0.57
150	2	0.23
200	2	0.23
700	1	0.11
Total	875	100.00
Did not respond	361	
Mean	7.97	

The actual responses to this question have been indicated in Table 3.5. The results have shown that the majority of organisations (71.5%) that responded to the survey employed fewer than five members of staff in the provision of building project price advice whereas only 7.4% indicated that they had more than fifteen members of staff involved. 25.83% of organisations that responded to this questions indicated that they were either sole practitioners or that they employed just one member of staff in the provision of building project price advice.

Given the spread of responses (minimum 1 to maximum 700) and the number of individual responses that attracted less than 1% of the total number of responses to the question it was resolved to group them into categories that would facilitate later statistical analysis. For instance, responding organisations that had the following numbers of staff, namely, 16, 33, 35, 60, 70, and 700, each attracted only 0.11% of all organisations responding to the question. Their continued inclusion in the results of the survey would make later statistical analysis difficult. Such an analysis would investigate whether there were any trends or bias between organisational size and use of individual models.

Accordingly the spread of responses was analysed and it was shown that the mean size of organisations that responded to this question was 7.97, the median was 3.00, the first quartile was at 1.00, and the third quartile was at 6.00. Therefore it was resolved to allocate the responses that had been received to question 4 (a) into the groupings shown in Table 3.6

Table 3.6 Size of organisations responding to Question 4 (a) - Grouped

Size of Organisation Nr of staff involved with strategic advice	Nr of Responses	% of Respondents
1 only	226	25.83
2 - 5	400	45.71
6 - 10	153	17.49
11+	96	10.97
Total	875	100.00
Did not respond	361	

3.5.6 Work distribution - question 4 (b)

The information gathered in relation to question 4(b) revealed the level or grade of staff involved in the production of building project price advice. This question had been included in order to make an assessment of whether the grade of staff that was mainly employed to formulate building project price advice had an impact upon the type of forecasting model that was utilised.

The results of the responses to this question have been set out in Table 3.7. The results have shown that building project price advice is most likely to be formulated at senior surveyor or partner/director level (72.3% and 37.9% respectively) than at surveyor or trainee level (19.9% and 9.5% respectively).

Table 3.7 Work distribution of organisations responding to question (4b)

Level of Staff	Mean % of total function	Minimum value	Maximum value	Standard deviation
Partner / Director	72.36	1.00	100.00	28.12
Senior Surveyor	37.94	1.00	100.00	19.74
Surveyor	19.99	2.00	90.00	14.85
Trainee	9.51	2.50	80.00	9.89

3.5.7 Building project price advice models - question 5

Generally

This question had seven distinct parts (questions 5 (a) to 5 (g)) to it. The question was set out in a tabulated format that facilitated the collection of a large amount of data that was related to the respondents use and perceptions of actual building project price advice models used in practice. The actual layout and content of the issues addressed in question 5 of the questionnaire form itself can be viewed in appendix 1.

Question 5 (a) asked respondents to indicate whether they had ever made any use of the models listed on the questionnaire form. If the respondents were to answer negatively to any of the models listed then question 5 (f) asked them to indicate, firstly, whether they understood how that model worked and secondly, question 5 (g) asked them to indicate whether their organisation had the capability to perform the model. These questions were included on the questionnaire form in an attempt to identify some of the factors that were thought to be preventing the individual building project price forecasting model from use and for comparison with the results obtained from Fortune and Lees' 1993 regional survey.

If the respondents did actually use any of the individual models listed in the questionnaire then they were asked to score each of them between 1 (low) and 4 (high) for their reliability and accuracy - question 5 (b), use of judgement - question 5 (c), value as a tool - question 5 (d), and current use of the model - question 5 (e).

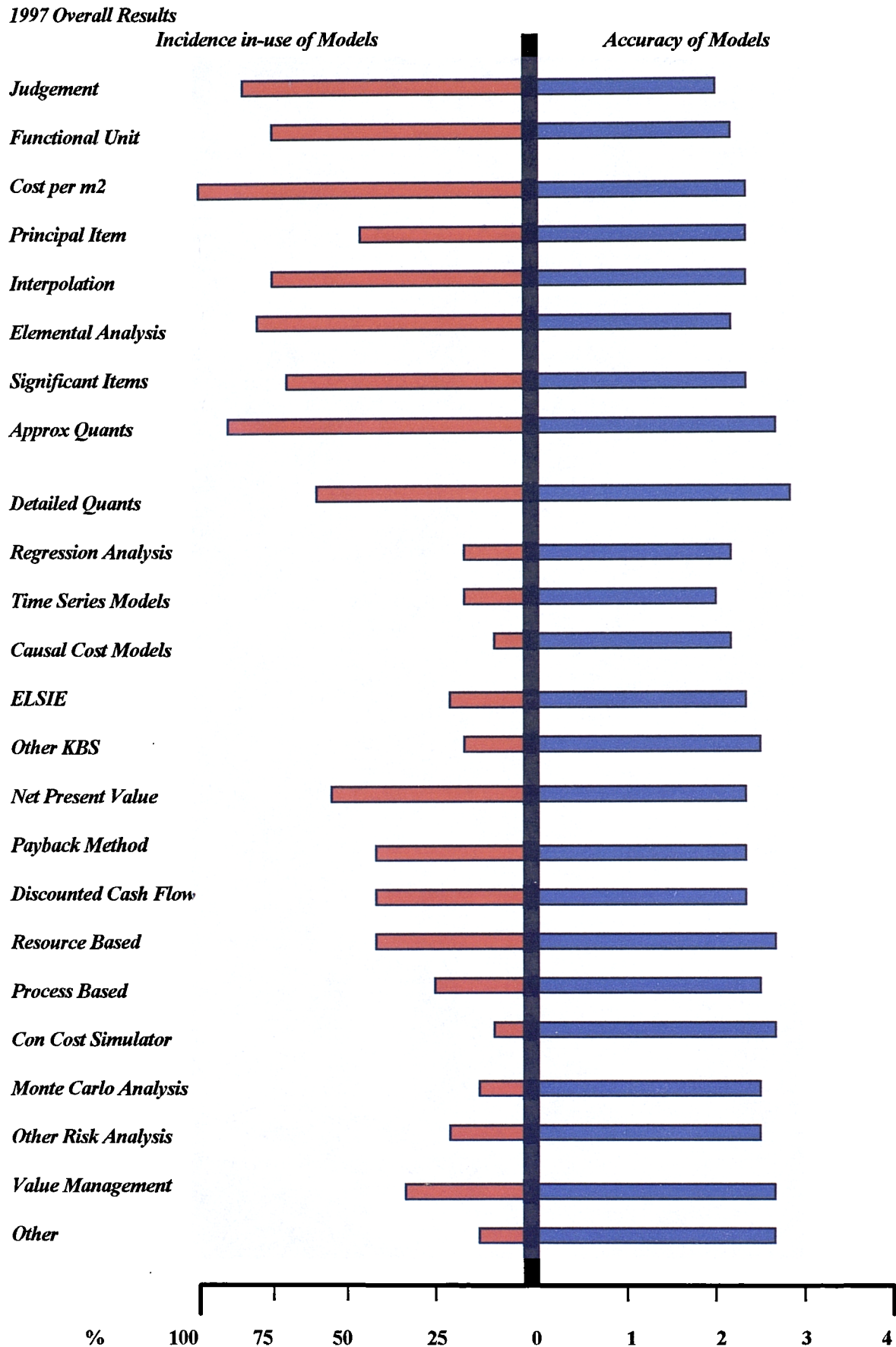
The responses to questions 5 (a), (b), (d), and (f) generated data that has allowed the study to determine the use and practitioner assessment of individual building project price advice models in use. Tables 3.8 and 3.9 report the results of each of the questions listed as 5 (a) to 5 (g) on the questionnaire form and they have been presented in appendix 2.

3.5.8. Incidence in model usage and accuracy - question 5 (a) & 5 (b)

The results obtained in relation to question 5 (a) and 5 (b) have been illustrated in Fig. 3.1. Model incidence in-use (% of respondents using individual models) has been illustrated on the left hand side (LHS) of Fig. 3.1. The respondents rating of the differing models listed in the survey for their accuracy, between one (low) and four (high), has been illustrated on the right hand side (RHS) of the diagram.

In general, Fig. 3.1 illustrated that the traditional type models were clearly the most popular, in terms of incidence in-use, of the building project price forecasting models listed on the survey form. Fig. 3.1 also illustrated that, in general, there was no pattern to the different scores awarded to the different types of building project price forecasting models for their relative levels of accuracy, by the forecasting practitioners that made use of them. The results for each price forecasting model type have been summarised below;

Fig. 3.1 - Model incidence in-use & perceived accuracy levels



(i) Traditional models

The traditional group of building project forecasting models had the highest incidence of use. The most popular of the traditional models were the cost per m² (96.9%) and approximate quantities (93.3%). The least well used of the traditional models was the principal item method (39.6%) and detailed quantities methods (63.4%). The use of the principal item method was thought to be particularly relevant to engineering projects that centred around a small number of highly significant work items. The respondent profile indicated above in Table 3.2 did not include any responses from organisations that styled themselves as being consulting engineers and so this would explain the low incidence in use of the principal item method amongst the traditional building project price advice models listed on the questionnaire form.

The individual models listed as traditional were scored for their accuracy by the forecasting practitioners in a range between 2.30 and 3.81. This range included models that were scored as the highest of all the models listed on the questionnaire form, namely, the detailed quantities method (3.81). This group of models also included the only other models that were scored over three out of a possible four in terms of accuracy and reliability, namely, the elemental analysis (3.17) and approximate quantities (3.53) types of models.

(ii) Statistical Models

The results have indicated that statistical models have a generally low incidence in use amongst construction professionals active in the field. The statistical based building project price advice models had, as a group, the lowest incidence in-use of the groups of building project price advice models that were listed on the questionnaire form. The lowest incidence of use of all the statistically based models listed was recorded by causal cost models which 94.8% of respondents to this question had not ever used

The individual models listed in this group of building project price advice models achieved the lowest mean rating for accuracy and reliability of the models listed on the questionnaire form. The highest of the statistical models listed achieved a score of 2.43 (causal cost models)

whereas the time series models (2.23) attracted the lowest rating of all the models listed on the questionnaire form.

(iii) Knowledge based models

A total of 15.4% of organisations that responded to the survey indicated that they had made use of the ELSIE expert system to formulate building project price advice. This expert system was the most well known of the computerised expert systems that were available but the survey did indicate that a further 13.4% of responding organisations had made use of one or more other types of expert system.

The models listed within this group were scored in mid-range for their accuracy and reliability when they were compared to the other groups of models listed on the questionnaire form. ELSIE was not scored as highly for accuracy and reliability as other knowledge based systems by those organisations responding to this question.

(iv) Life cycle costing models

The survey indicated that the differing models used to provide clients with an indication of a building projects price advice in terms of its life cycle costs were used evenly by the construction professionals active in the field. As a group of models this group had the second highest incidence in use amongst the organisations responding to this question.

The models listed within this group were scored below the collective mean scores for all the groups of models listed in terms of their accuracy and reliability. Net present value (2.33) and the payback method (2.58) were the lowest and the highest scored models respectively in this grouping.

(v) Contractors resource / process based

The relatively high incidence in-use of resource based models indicated that practitioners made use of basic prices of labour, materials and plant as well as tendered prices of finished work. The lower incidence in-use of process based models may be caused by the lack of

project programming information at an early stage in the life of the proposed project. The construction cost simulator had the lowest incidence in use (5.00%) of all the models that were listed on the questionnaire form.

This group of models achieved a mid-range rating as a group of building project price forecasting models in terms of their accuracy and reliability. Resource based (2.89) and process based (2.65) were the models that were scored the highest and the lowest in this grouping.

(vi) Risk analysis models

The results of the survey have indicated that the risk analysis models had a low incidence in use amongst construction professionals active in the field. The lowest incidence in-use was recorded by the monte-carlo simulation method (12.63%). The results indicated that a further 23.3% of organisations that responded to the survey had made use of other types of risk analysis models.

This group of building project price forecasting models were scored below the mean for accuracy and reliability as compared to the other groups of models included on the questionnaire form. The models in this group included monte-carlo simulation which was scored (2.49) as well as a group termed as 'others' which were scored at (2.53).

(vii) Value related models

The use of value management (32.6%) by the organisations that responded to this question indicated that this was the most used of the value related models. The results also indicated that a further 9.6% of respondents made use of other value related models.

This group of models were collectively scored as the second highest grouping of models in terms of their scores for accuracy and reliability. The model listed as 'other' was scored the highest at 2.83.

(ix) General Comment

The overall results reported in Table 3.8 and illustrated in Fig. 3.1 show that there were differing types of building project price forecasting models in-use within quantity surveying organisations that were operating in England in 1997. The results have also shown that the paradigm shift towards the newer non-traditional models, called for by Brandon (1982), has not yet been achieved by the general population of quantity surveying organisations that were operating in England in 1997.

The results, as presented, have not provided an indication of whether the resistance to changing the paradigm of building project price forecasting model usage was the same across variables such as differing organisational types, sizes, and ratio of staff to computer workstations.

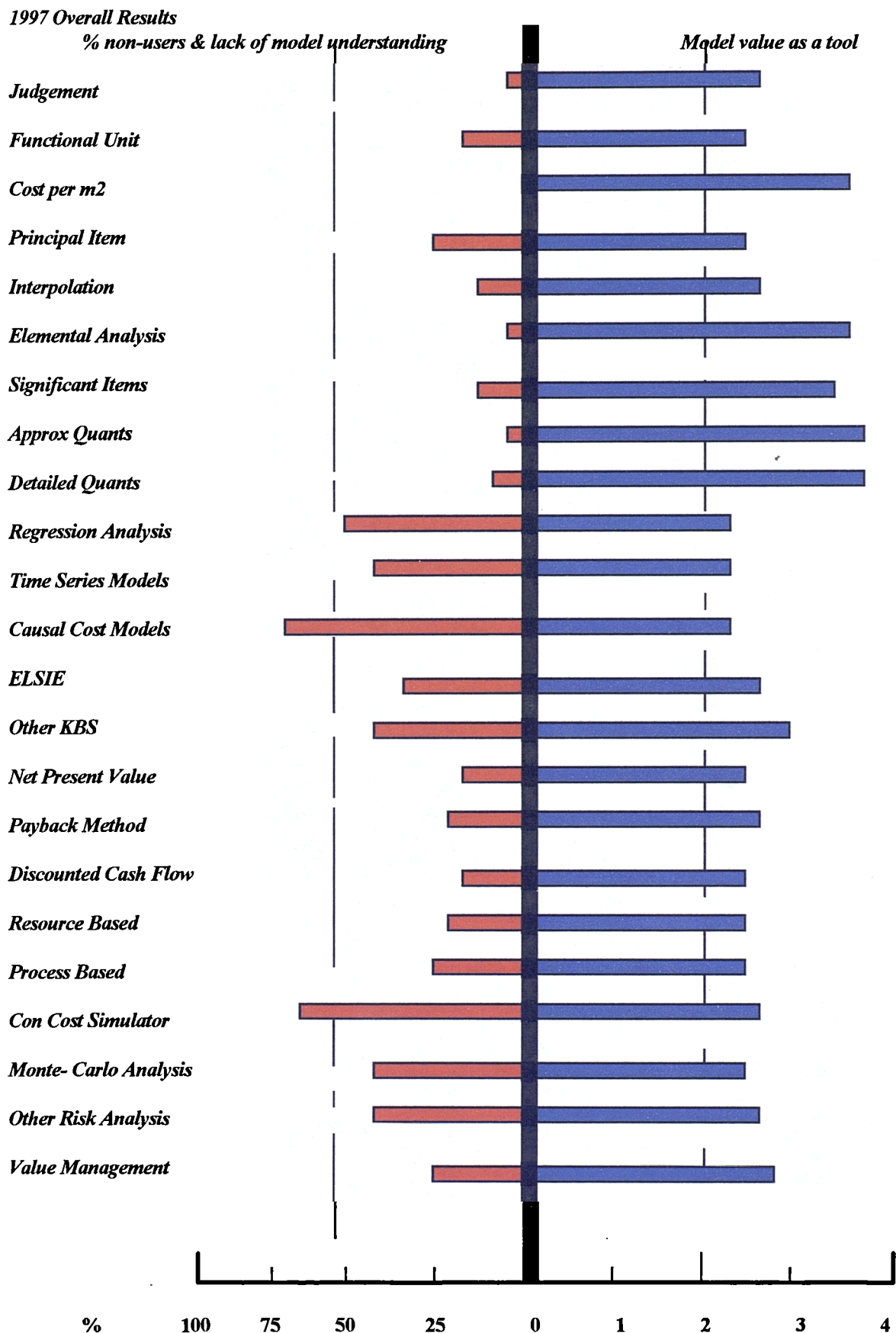
Similarly the results, as presented, have not provided any indication of whether differing types and sizes of quantity surveying organisations have scored the models differently for their relative levels of accuracy. Further statistical analysis of the data generated by the survey, in order to investigate potential differences in model usage and relative levels of accuracy, has been undertaken and reported in chapter 4.

3.5.9. Model understanding and value as a tool question

The results obtained in relation to question 5 (d) and 5 (f) have been illustrated in Fig. 3.2. Levels of model understanding (% of respondents not using individual models and their levels of non-understanding) have been illustrated on the left hand side (LHS) of Fig. 3.2. The respondents rating of the differing models listed on the survey form for their value as a tool, between one (low) and four (high), have been illustrated on the right hand side (RHS) of the diagram.

In general, Fig. 3.2 illustrated that the traditional type models that were not used by the survey's respondents were nevertheless understood. In terms of the newer computerised models, the levels of understanding were not so explicit. For example, 17.9% of the respondent who indicated that they did not use the net present value technique also indicated

Fig 3.2 - Lack of model understanding as a factor affecting incidence in use & model value as a tool



that they did not understand how the technique worked. The LHS of Fig 3.2 shows that only the life cycle group of models achieved a better than average level of understanding amongst the survey's respondents who indicated that they made no use of the life cycle cost models in practice. The results have shown that lack of model understanding was a significant factor affecting the non-use of the non-traditional groups of models by construction professionals in the field. Fig 3.2 also illustrated that, in general, there was no pattern to the different scores awarded to the different types of building project price forecasting models for their relative value as tools, by the forecasting practitioners that made use of them. The results for each price forecasting model type included in the survey have been summarised below,

(i) Traditional models

The traditional group of building project forecasting models had the lowest level of non-understanding by respondents to the survey. The least well understood of the traditional models were the principal item (19.33%) and interpolation methods (12.80%). The results clearly indicated that although practitioners did not always make use of all of the traditional type models they did, in general, understand the models and so other factors must have been affecting their model selection decisions.

The individual models listed as traditional were scored for their value as tools for the forecasting practitioners in a range between 2.35 and 3.52. This group were collectively scored as the most valuable group of models by the survey's respondents. The scoring range for this group of models included models that were scored as the highest of all the models listed on the questionnaire form, namely, the approximate quantities method (3.52). This group of models also included the only other models that were scored over three out of a possible four in terms of their value as tools, namely, the elemental analysis (3.19) and detailed quantities (3.49) types of models.

(ii) Statistical models

The results have indicated that statistical models were generally poorly understood amongst construction professionals active in the field. The statistically based building project price advice models had, as a group, the highest level of non-understanding of all the groups of

building project price advice models that were listed on the questionnaire form. The highest level of non-understanding, amongst models in this group, was recorded by the causal cost model, of which 63.3% of respondents indicated that they had no understanding. For this model the results have shown that lack of model understanding was the most important factor affecting its selection for use.

The individual models listed in this group of building project price advice models achieved the lowest mean rating of the models listed on the questionnaire form for their value as tools to aid the forecaster practitioners. The highest of the statistical models listed achieved a score of 2.33 (causal cost models) whereas the time series models (2.26) attracted the lowest rating of all the models listed on the questionnaire form.

(iii) Knowledge based models

A total of 34.2% of respondents who indicated that they did not make any use of the ELSIE expert system when formulating their building project price forecasting advice also indicated that they did not understand the system. This level of non-understanding was above the mean levels established for the models listed on the survey form. This expert system seemed to be the most well understood of the expert systems that respondents indicated that they used.

The models listed within this group were scored above the mid-range for their value as tools by the survey's respondents when they were compared to the other groups of models listed on the questionnaire form. ELSIE was not scored as highly for its value as a tool as other knowledge based systems by those organisations responding to this question.

(iv) Life cycle costing models

The survey indicated that the differing models used to provide clients with an indication of a building projects price advice in terms of its life cycle costs were the second most well understood of the available building project price forecasting models. The discounted cash flow method (23.8%) was the least well understood of the models listed in this group.

The models listed within this group were scored below the collective mean scores for all the groups of models listed in terms of their value as tools to construction professionals active in

the field. Net present value (2.59) and the payback method (2.64) were the lowest and the highest scored models respectively in this grouping.

(v) Contractors resource / process based

The levels of non-understanding amongst construction professionals of resource and process based models (29.9% and 31.7%) were in mid-range when compared to other levels of model non-understanding. The construction cost simulator had the highest level of non-understanding (63.7%) of all the models that were listed on the questionnaire form. For this model the results have shown that lack of model understanding was the most important factor affecting its selection for use

This group of models achieved a mid-range rating as a group of building project price forecasting models in terms of their value as tools to aid forecaster practitioners. Resource based (2.59) and construction cost simulator (2.65) were the models that were scored as the lowest and the highest in this grouping.

(vi) Risk analysis models

The results of the survey indicated that the risk analysis models had above average levels of non-understanding amongst construction professionals active in the field. The highest level of non-understanding was recorded for the monte-carlo model at 43.7%.

This group of building project price forecasting models were scored below the mean for their value as tools for forecaster practitioners, as compared to the other groups of models that were included on the questionnaire form. The models in this group included monte-carlo simulation which was scored (2.50) as well as a group termed as 'others' which were scored at (2.63).

(vii) Value related models

The extent of non-understanding of value management (27.9%) by the organisations responding to this question was at the mean level of non-understanding for all the models listed on the questionnaire form.

This group of models were collectively scored as the second highest grouping of models in terms of their scores for value as tools that aided practitioners involved in the formulation of building project price forecasting. The model listed as 'other' was scored the highest at (2.87).

The overall results reported in Tables 3.8 and 3.9, and illustrated in Fig. 3.2 have shown that there were differing levels of building project price forecasting models understanding amongst construction professionals active in the field. Of the models listed, only two, namely, the causal cost model, and the construction cost simulator had levels of non-understanding in excess of 50%.

(viii) General comment

In general, the results of the survey indicated that although lack of model understanding was a factor affecting the selection of some of the newer non-traditional price forecasting models, it was a dominant factor in the selection of only a minority of the models listed. Therefore, other factors affecting model selection needed to be identified and their significance established in order to unravel the forecast formulation stage of the building project price forecasting process. The unravelling of the other more positive factors that affected building project price forecasters in their selection of types of models or tools needed further work that sought to gain insights into how and why certain types of newer non-traditional models were selected for use. Such a research problem called for a qualitative approach to be adopted.

3.5.10 Other models in-use - question 6

This question was included on the survey form in order to establish the identity of all of the newer non-traditional models used by quantity surveying organisations that were operating in England in 1997. Table 3.8 indicates that 13.4%, 23.3% and 9.0% of respondents made use of other types of knowledge based, risk analysis and other general models respectively.

The results have indicated that a total of 22 respondents answered this question 1.8% of the respondents to the survey. The actual responses have been summarised in Table 3.10 below.

The inappropriate responses indicated in Table 3.10 included responses such as, 'value engineering, risk analysis, and monte-carlo simulation', which although responses to the question asked were not helpful in identifying the actual model used.

Table 3.10 'Other' building project price forecasting models in-use

Model Name / Type	Number of Occurrences
In-house cost database	5
In-house expert system	2
In-house risk analysis software	4
Predict risk analysis software	1
Live options cost modelling system	1
Multiple estimating risk analysis package	1
Inappropriate response	8
Total number	22
% of respondents	1.78

The small number of responses to this question (2.67%) has indicated that the question was only partially successful in achieving its aim, in terms of identifying the full range of building project price forecasting models in-use. However, the high percentage of respondents to the question that have indicated other 'in-house' models (50%), without revealing their exact nature, has suggested that this question could have been seen as asking about commercially sensitive information. If this was the case then some of the more 'leading edge' organisations would not wish to reveal the nature of their price forecasting model in use so as to preserve their commercial advantage.

The type of data generated by this survey did not allow such issues to be settled and called for further work, of a more qualitative nature, to be undertaken in order to establish model identity, and selection criteria.

3.5.11 Contacts for further work - question 7

This question was included on the survey form in order to establish the identity of individuals and organisations that were willing to participate in further follow-up studies. This was one of the reasons why it was decided to conduct a population survey of all quantity surveying organisations that were operating in England in 1997.

A total of 167 responses were received to this question. This indicated that 12.9% of the respondents to the survey were willing, initially, to participate in further work.

Accordingly an additional communication was sent to each of the persons named in response to this question. The communication included a cover letter which explained the purpose of the further work and a sheet that requested biographical and contextual information. All potential participants were asked to give biographical details, such as, name, age, job title, and professional qualifications. In addition, each of the potential participants were asked to indicate their own personal awareness and practical knowledge of each of the main groups of building project price forecasting models listed on the survey form.

Responses to both of these questions, when combined with the organisational information already obtained from the main survey would enable the most appropriate of them to be selected as participants in the qualitative investigation that was designed as being phase two of the study.

A total of 95 responses were received from the initial respondents to this questions. This represented a 56.1% response rate to the communication. It was decided not to initiate any follow-up procedures as the number of confirmed participants was satisfactory. The participants that confirmed that they were willing to act as participants in a further study represented 7.3% of all the respondents to the main survey. The confirmed participants listed

formed the subject frame from which the actual participants in the qualitative investigation that was designed as being phase two of the study were drawn.

3.6 Summary and reflections on the research process

3.6.1 Summary

This chapter started by considering the research approaches that could have been adopted to resolve the problems identified as a result of the review of literature undertaken in chapter 2. The adoption of a single paradigm was rejected in favour of a pragmatic approach that sought to match the research problems under investigation to the most appropriate methodology available. Consideration was also given to the investigators philosophical viewpoint and the availability of resources. Accordingly a two-phased combined methodology was eventually adopted for the work following successful bids for additional internal institutional administrative support and external funding from the RICS.

It was decided to use a mailed questionnaire as the means of collecting data from the population of quantity surveying organisations that were operating in England between January and May 1997.

Such an approach was decided upon in order to reduce bias due to sampling error, facilitate external validity, identify participants for the second phase of the study, generate data for comparison with previous survey work, and generate data for future trend analysis, it was decided to undertake a population survey of all 2327 quantity surveying organisations listed by the RICS as operating in England in 1997.

The earlier survey work of Fortune and Lees (1993) was considered. The results generated by the measuring instrument used for that regional study had proved that the questionnaire form it had used was internally valid. It was decided to use the questionnaire form from the 1993 survey as the core of the measuring instrument for this study and make amendments to it in order to reflect the key information sources indicated above. Accordingly, two supplementary questions were added to the proposed form in order to (i) allow respondents to identify other models that they may make use of but which not named on the form, and to

(ii) identify contacts for future work. The adoption of the previous form also enabled the work to draw comparisons and identify movements in model usage from organisations that were located in the northern regions of England in 1993 and 1997.

The survey achieved an overall response rate of 55.7% from the 2327 organisations that comprised the population of quantity surveying organisations that were operating in England in 1997. This high response rate was achieved following two waves of follow-up activity amongst the non-responding organisations.

The main results of the survey were,

- * In terms of types of organisation making up the population it was found that 70.9% were quantity surveying practices, 10.1% were multi-disciplinary in nature, and 9.4% styled themselves as project management consultants.

Organisations that styled themselves as being architectural practices, management, design and build, and specialist contracting organisations, together accounted for less than 1% of all respondents to the survey and so their separate inclusion in any subsequent statistical analysis of the data was not considered to be feasible.

- * In terms of topic significance the survey found that 91.3% of its respondents were involved in providing building project price forecasts

- * In terms of computing facilities the survey found that 77% of respondents had a staff to workstation ratio of 2:1 or better. However, the survey also found that 6.2% had no computing facilities at all and a further 5.7% of respondents had staff to workstation ratios of more than 3:1.

- * In terms of size of organisation, measured as the number of its staff members engaged in the building project price forecasting process, the survey found that 71.5% employed five or less than five people. 25.8% of all the survey's respondents employed just one person. 11.0% of all respondents to the

survey indicated that they engaged eleven or more persons in the building project price forecasting process.

The incidence in-use of building project price advice models, the extent of model non-understanding, the relative scores for model accuracy, level of model understanding, and value as tools were illustrated in Figs. 3.1 and 3.2. In general terms the survey found that,

- * The traditional types of models were clearly the most popular, in terms of their incidence in-use. The least popular with construction professionals active in the field was the statistically based group of models. This pattern was repeated in terms of the respondents scores of the models in-use for their accuracy, with the traditional group of models being scored the highest and the statistical group of models being scored as the least accurate.
- * The traditional types of models that were not used by the survey's respondents were nevertheless understood. In terms of the newer non-traditional types of models the levels of understanding were not so explicit and only the life cycle group of models achieved a better than average level of understanding. The results have shown that lack of model understanding was a factor affecting the non-use of the newer non-traditional types of models by construction professionals in the field. Lack of model understanding was the main factor affecting the non-use of causal cost models and the construction cost simulator.
- * In general, the survey found that there was no clear pattern between the perceived levels of accuracy achieved by traditional and non-traditional models. The much smaller number of building project price forecasters using non-traditional models found them to be as accurate as the traditional models that the majority of building project price forecasters in the field were continuing to use.

In addition the survey found that,

- * 3.6% of respondents identified other models that they used but which were not listed on the questionnaire form. This is only a small number of the actual respondents to the survey that indicated that they used of other types of risk analysis models (23.3%) and other types of value related models (9.6%). Of the responses to this question some 55% indicated that they made use of their own 'in-house' system which was not named for reasons that were suspected as being related to commercial advantage.

In terms of contacts for the more qualitative second phase of the study the survey resulted in,

- * The identification of 167 respondents who were willing to co-operate in further work on the topic. It was subsequently found that a total of 95 of them confirmed that they were willing to be interviewed at their place of work when they returned biographical and contextual information about themselves. This information was to be combined with their organisational information to produce a subject frame from which the actual participants in the second phase of the investigation would be drawn.

In general the results of the survey mapped out the state of the art in terms of building project price forecasting models in-use. The survey found that, in terms of quantity surveying organisations operating in England in 1997,

- * The traditional type of building project price forecasting models had the highest incidence in-use amongst construction professionals active in the field.
- * Non-traditional types of building project price forecasting models, such as statistical, knowledge based, life cycle, resource/process based, risk, and value related models were also in-use, but no evidence was found of the use of the following models that had been suggested as being available by academics in the field, namely,
'conference method, comparison method, cubic method, storey-enclosure method, graphical method, superficial perimeter method,

exponent method, financial method, dynamic and linear programming method'

- * The paradigm shift towards the newer non-traditional models, called for by academics such as Brandon (1982), had not yet been generally achieved .
- * Lack of model understanding was a factor affecting the non-use of the newer non-traditional building project price forecasting models but it was only the main factor that affected the non-use of causal cost and the construction cost simulator models.
- * Other factors, as yet not identified, affected the selection of building project price forecasting models for use by construction professionals in the field.

3.6.2 Implications for further work

The results, as presented above, have not provided an indication of whether the resistance to changing the paradigm of building project price forecasting model usage was the same across variables such as differing organisational types, sizes, geographical location, and ratios of staff to computer workstations.

Therefore, further statistical analysis of the data generated by the survey, now needed to be undertaken in order to,

- * investigate potential differences in the incidence in-use of building project price forecasting models, across the organisational variables of type, size, geographical location, and ratio of staff to workstations.

The survey indicated that although lack of model understanding was a factor affecting the selection of some of the newer non-traditional price forecasting models, it was not a dominant factor in the selection of the majority of the models listed. Therefore, other factors affecting model selection needed to be identified and their significance established in order to unravel the forecast formulation stage of the building project price forecasting process.

The identification of other model selection factors called for further work to be undertaken that needed to,

- * explore the building project price forecasting model selection process on a more qualitative basis with construction professionals active in the field.

3.6.3 Reflections on the research process

The activities undertaken and reported upon in this chapter has resulted in skills being developed in the use of quantitative approaches to the resolution of research problems. Prior to the development of such skills it was necessary to discover a personal approach to the philosophy of research itself. This called upon the researcher to become familiar with the main philosophical approaches available. The research log kept for the work revealed that this process of self-discovery, in terms of personal research philosophy, took a period of time which at the time, seemed to be holding up progress on the work.

However, on reflection, the time needed to discover what was later termed as a pragmatic approach to research philosophy was fundamental to the understanding of the research process itself. Such a personal approach to problem solving sought to match the research questions under investigation to the most appropriate of the research methodologies available rather than dogmatically fitting a preferred research style to the research problems being investigated.

The research log also revealed that the adoption and execution of the pragmatic two-phased combined research design resulted in considerable amounts of administrative type work. The administration of such a large scale mailed questionnaire placed a heavy burden on the limited resources available for the work.

The issue of the survey called for a total of 4690 envelopes to be addressed, filled with a cover letter, questionnaire form, and an addressed return envelope, before being sealed and mailed. The 1296 responses to the survey generated over 225,000 separate pieces of data that needed to be coded and entered onto spreadsheets prior to being introduced to the Minitab 10 statistical analysis package.

A successful bid for internal institution funds allowed some administrative support to be provided for the survey data preparation and entry process. The potential for error was combatted by rigorous issue procedures and record keeping. The data entry process was checked for the accuracy of its coding. Data was manipulated with care within the statistical analysis package used. Although the amount of physical effort required to undertake such a large scale quantitative investigation can be anticipated, the research log for the work has indicated that valuable lessons have been absorbed in terms of approach to sampling, questionnaire formatting, issue and follow-up procedures, as well as data entry handling strategies for the future.

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Chapter 4

Analysis and Discussion of Survey Results

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Chapter 4

Analysis and Discussion of Survey Results

4.1 Introduction

4.1.1 General

In order to fully establish the ‘state of the art’ in terms of how building project price forecasters actually formulate their forecasts in England in 1997 it was necessary to analyse the results of the nation-wide survey that were reported in chapter 3. Such statistical analysis enabled quantitative evidence to be assembled in relation to some of the major research objectives set for the work. The data generated by the analysis allowed conclusions to be drawn on issues affecting the incidence in-use of particular types of model and the extent of any movement towards the paradigm shift called for by academics such as Brandon (1982) within organisations of certain types and sizes.

The first section in this chapter considered the nature of the data summarised and presented in chapter 3 in order to determine hypotheses that could then be tested for by the application of the most appropriate statistical test. The subsequent sections within the chapter take each hypothesis in turn and considers the results of the statistical analysis that was applied to it in order to determine whether that particular hypothesis could be rejected or not rejected. The chapter has been concluded with a summary that brings together all the findings from this quantitative investigation and a reflection on the research process in terms of what was the achievements and shortcomings within this phase of the work.

In order to facilitate analysis and discussion it was necessary to formulate appropriate hypotheses, and then consider the nature and type of data collected and reported on in chapter 3. This consideration enabled a relevant statistical test to be applied and statistically significant results reported.

4.1.2 Hypotheses generation and testing process

The implications of the results of the survey that were reported in chapter 3 required the sets of data that had been generated to be manipulated and analysed in order to,

- * investigate potential differences in the incidence in-use of building project price forecasting models, across the organisational variables of type, level of computing facility, size, and lack of model understanding.

- * investigate whether organisations located in the different regions of England (north and south, including London) had differences in their incidence in-use of particular groups of building project price forecasting models

Therefore, it was proposed to analyse the data generated by the organisations that responded to the survey in order to determine whether the null hypotheses for the following major issues could be rejected or not rejected,

- (i) There was no difference between the data sets gathered from differing types of organisation and the incidence in-use of building project price forecasting models other than that caused by chance.

- (ii) There was no difference between the data sets gathered from organisations with differing staff to computer workstation ratios and the incidence in-use of building project price forecasting models other than that caused by chance.

- (iii) There was no difference between organisations of differing size and the incidence in-use of building project price forecasting models other than that caused by chance

- (iv) There was no difference between organisations located in the north and south of England and the incidence in-use of building project price forecasting models other than that caused by chance.

The data generated by the survey was analysed using the Minitab 10 statistical package within the standard Windows software system. In order to make use of the software package it was necessary to determine which statistical test was the most appropriate to apply to the data collected.

Cramer (1994, p.53) sets out the reasons for undertaking statistical tests and the choices available. Firstly, Cramer asserted that statistical tests were undertaken to establish whether *'two or more variables were related or whether two or more groups differed on some variable'*.

In terms of this study the data generated needed to be analysed in order to test for differences between their actual and expected counts and the strength of any association discovered. For instance the actual incidence in-use of particular building project price forecasting models between different groups of respondents, classified by type, size, extent of computing facilities, and geographic location, needed to be analysed in order to determine whether any patterns and trends in the data were statistically significant or were just the result of chance.

Secondly, Cramer (1994, p.53) pointed out that the type of data collected affected the type of statistical test that could be applied.

For instance, in this study the survey form was designed to collect data that were capable of being categorised into different groups. In addition, the data were suitable for being manipulated to reflect the scores or ratings given by practitioners, within their organisational settings, in terms of their perceptions of model performance in terms of accuracy and value as tools. The measuring instrument designed for this study has therefore collected both nominal and non-nominal data.

Thirdly, Cramer (1994, p.40) then asserted that assumptions needed to be made about the way the values of the variables were distributed. '*non-parametric tests do not depend upon the distribution of the variables whereas parametric tests did*'. The power of a statistical test and its capability of detecting significant differences or significant relationships between individual variables or groups of variables in the data being analysed was reflected in whether the tests were *parametric* (or powerful) or *non-parametric* (less powerful) in nature.

Nachmias and Nachmias (1976), Greene and D'Olivera (1982), and Fink (1995) indicated that parametric tests should only be applied in the following circumstances, namely when (i) the variables were measured with an equal interval or ratio scale, (ii) the samples were drawn from populations whose variances were equal or homogeneous, (iii) the samples were drawn from populations whose distributions were normal.

The sources indicated above also acknowledged that there was no absolute consensus on all of the above criteria. However, there was agreement amongst them that the first criteria, namely the type of data upon which the statistical test was to be applied, was critical.

The data in relation to survey questions 1, 2, 4, and parts of 5, specifically 5 (a), and 5 (f), related to the key variables of organisational type, extent of computing facility, organisational size, incidence in-use of particular models, and model non-understanding. The data generated in relation to these questions were all capable of being allocated into differing categories. According to DeVaus (1996, p.130) data were '*nominal*' in nature when '*it was possible to distinguish between categories in a variable but it was not possible to rank the categories in any order*'.

The data related to the survey questions listed above were nominal in nature. Therefore any statistical test applied to such data had to be of a *non-parametric* type.

Greene and D'Olivera (1982, p.45) and Cramer (1994, p.55) indicated that the following were non-parametric statistical tests of differences in nominal data sets, namely, the binomial, the chi-square, the McNemar, and Cochran Q tests. The available non-parametric tests indicated applied to both *related* and *unrelated* data. As the data from the survey had been

gathered from different individuals within different organisations then it can be said to be *unrelated* in its nature. In such cases the sources indicated above directed that the following were the most appropriate of the non-parametric tests indicated above, namely, the binomial or the chi-square tests.

Cramer (1994, p.98) indicated that the binomial test was applicable when the '*number of cases fell into one of only two categories*' and that the chi-square test was appropriate when '*the data had two or more unrelated samples on a variable with two or more categories*'.

Given the nature of the data related to the key variables of, organisational type, organisational size, and the extent of computing facilities within an organisation, and their relationship to the incidence of model use (survey questions 1, 2, 4, and 5a), it was decided to use *crosstabulations and the chi-square non-parametric test* to establish whether there were any statistically significant differences between the actual and expected frequencies of models in-use and the data sets grouped according to the organisational settings of each of the respondents.

Conventionally, the level of statistical significance with the statistical test indicated above has been set at either the 0.05 or the 0.01 level. DeVaus (1996, p.191) indicated that using the 0.05 level to test large samples ran the risk of '*too easily rejecting the null hypothesis and therefore making a Type 1 error*'. However, DeVaus went on to say that the trouble with using the 0.01 level of significance was that it could '*lead to Type 2 errors being made i.e accepting the null hypothesis when it should have been rejected*'.

Therefore, it was resolved generally to test the null hypotheses (i) to (iv) as set out above, to establish whether there were any relationships between the data sets under analysis other than those caused by chance at the 0.99 level ($p < 0.01$). Should any differences be found that were significant at the 0.95 level ($p < 0.05$) then they have been reported as such and their level of significance noted.

Greene and d'Olivera (1982, p.70) indicated the way in which the chi-square statistic (χ^2) was calculated and stated that '*the chi-square test was used to compare the observed*

frequencies in each of the squares of a contingency table with the expected frequencies for each cell'.

Hinton (1995, p.250), indicated that the chi-square test had to be considered as unsafe and prone to producing results that were liable to have Type 1 errors, i.e. the erroneous rejection of the null hypothesis, when it should in fact have been not rejected, if cells within a contingency table had expected frequencies of less than 5. Hinton (1995) went on to suggest that when there was such an analysis with $df=1$ then the Yates correction for discontinuity should be applied. This adjustment was applied to data in such circumstances and it has allowed significant and non-significant cases to be reported with increased confidence.

Bryman and Cramer (1996, p.162) discussed the advantages and disadvantages of using the chi-square test. They pointed out that one of the limitations of using the chi-square test was that *'it did not produce a strong statistic in that it did not convey information about the strength of a relationship'*. In addition Bryman and Cramer (1996, p.170) indicated that results which reported only the statistical significance of relationships were potentially erroneous since *'what was significant and what was not significant was profoundly affected by the number of cases being investigated'*. Given the large scale nature of the survey data being analysed it was resolved to investigate the strength of any statistically significant relationships discovered following the use of the chi-square test.

Cramer (1994, p.186) asserted that tests for association for nominal data were either derived from the chi-square statistic (such as the phi coefficient and Cramers V) or were based on the proportional reduction in error (such as the Goodman and Kruskal's lambda and tau). DeVaus (1996, p.169) provided a rationale for the selection of the most appropriate of the available measures of association. It was indicated that for contingency tables that were larger than 2x2 then the most insensitive measure that could be used was lambda and the most sensitive of the available measures was the Goodman and Kruskal's tau. However, DeVaus (1996, p.168) also indicated that Cramer's V was

'a satisfactory alternative' in situations where the most appropriate test of association was not available in the statistical analysis software package being used.

Minitab10 did not have any of the above tests of association available and so it was decided to make a manual assessment of the strength of associations within the data sets being analysed by using the following formula,

$$\text{Cramer's } V = \sqrt{\frac{\text{chi-square } (x^2)}{\text{Number of cases } \times (\text{smaller number of rows/columns} - 1)}}$$

Bryman and Cramer (1996, p.169) cited Cohen and Holliday (1982) in putting forward the following rule-of-thumb guidelines for interpretation of correlation statistics, namely, '*0.40 and below was termed as low or weak; 0.40-0.69 was termed modest or moderate; 0.70 and above was termed high or strong*'. Although it was stressed by Bryman and Cramer (1996) that there was no consensus on such labels amongst statisticians, it was nevertheless decided to use the rule-of-thumb classifications advocated above together with the chi-square statistic achieved when the results of the analysis were discussed below.

The results of the statistical tests applied to investigate each of the hypotheses related to the major issues indicated above have now been presented together with a discussion on the implications of their findings.

4.2 Statistical tests, results and implications

4.2.1 Generally

Appendix 3 contains Tables 4.1 - 4.7 which show the full results of the cross-tabulations and chi-square tests, set at the 0.001 level, which were applied to the data as indicated above. Each of the hypotheses (i) - (iv) listed above have been considered below in terms of its results and implications

4.2.2. Organisational type and model incidence in-use

Table 4.1 shows the results of the crosstabulation of the data related to organisational types and the frequency in-use of building project price forecasting models. A visual inspection of the crosstabulated data presented in Table 4.1 indicated the following patterns in the percentage differences between actual and expected frequencies of model incidence in-use, namely,

- (i) organisations classified as being of a contracting or other nature had a consistently lower frequency of actual usage when compared to expected incidence in-use of all the models listed on the questionnaire form,
- (ii) quantity surveying and local authority types of organisations had a consistently lower frequency of actual when compared to expected incidence in-use of all the newer types of building project price forecasting models, and
- (iii) multi-disciplinary and project management types of organisations had a consistently higher frequency of actual when compared to expected incidence in-use of all the newer types of building project price forecasting models .

The crosstabulations for typical data sets that showed the percentage differences between actual and expected model incidence in-use have been illustrated in Figs 4.1 and 4.2. Accordingly a chi-square test was applied as indicated above. A statistical difference in the frequency of model incidence in-use was detected between differing types of organisations. This difference was significant at the 0.001 level, in nineteen of the twenty-four individual models across the following groups,

traditional, life-cycle, resource/process based, risk analysis, and value related models.

Furthermore, the chi-square test indicated that there was a statistical difference in the frequency of model incidence in-use which was significant at the 0.05 level in an additional three of the individual models in the following groups,

knowledge based, and the statistically based group (except for causal cost models)

The statistical analysis undertaken to investigate hypothesis (i) has established that although there was a danger of a Type 1 error in the three results reported at the 0.05 level, the size of

Fig 4.1 Type of Organisation and Use of Model
% Difference Actual to Expected Count

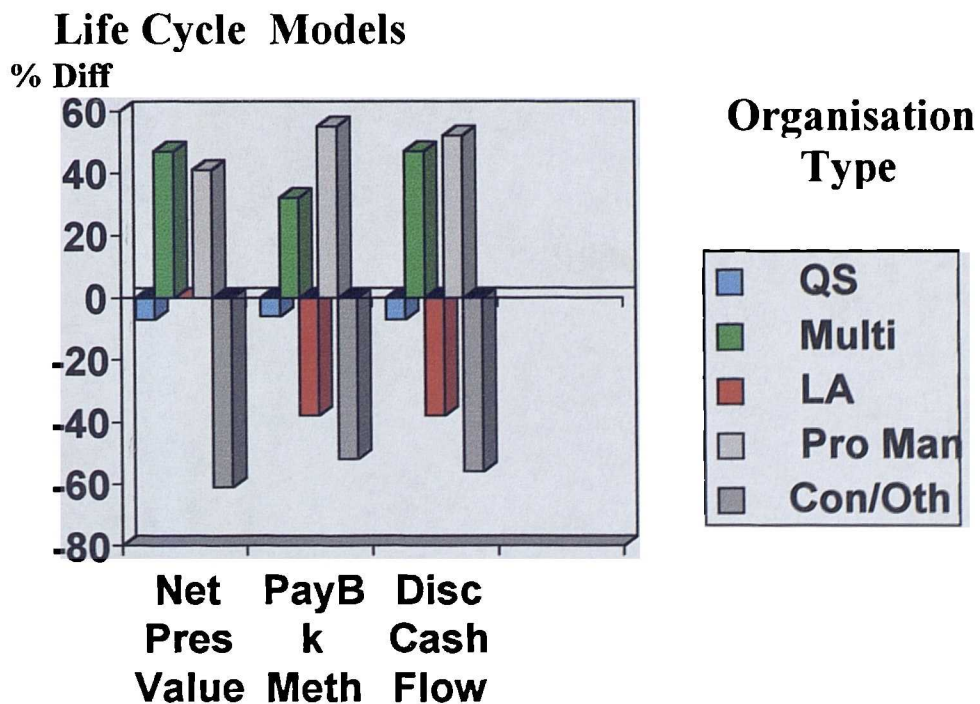
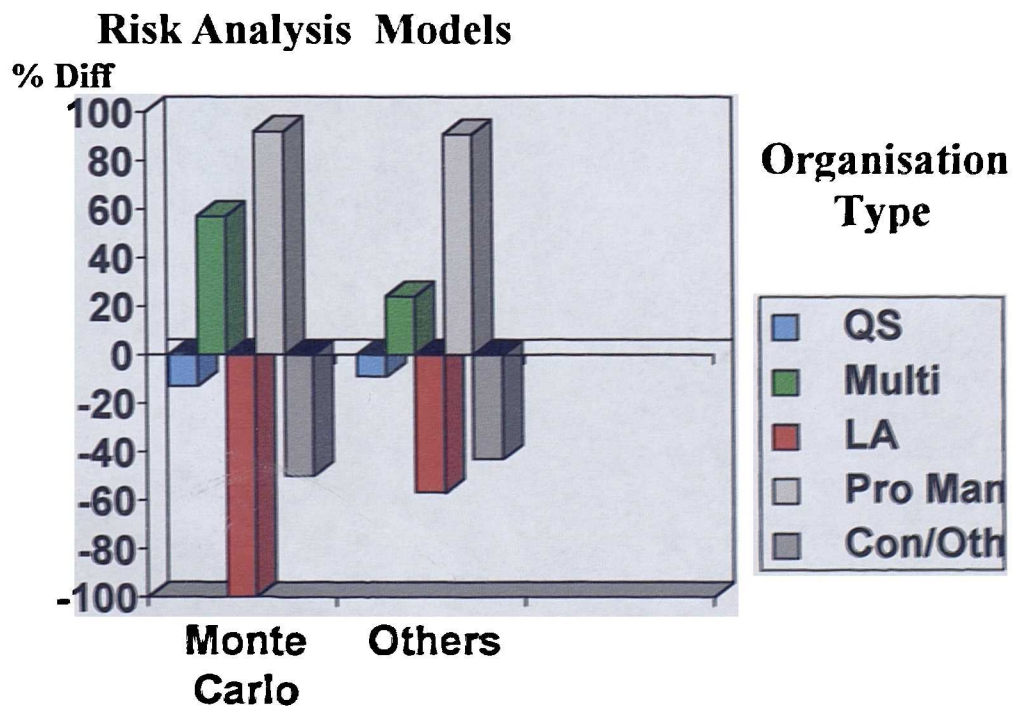


Fig 4.2 Type of Organisation and Use of Model
% Difference Actual to Expected Count



the chi-square statistics calculated across the clear majority of the models listed provided evidence of a relationship between organisational type and model incidence in-use that could not be caused by chance. Given such evidence the null hypothesis (i), namely,

- (i) *There was no difference between the data sets gathered from differing types of organisation and the incidence in-use of building project price forecasting models other than that caused by chance*

was rejected.

Therefore, it was concluded that there was a statistically significant relationship between organisational type and model incidence in-use at a level of 0.001 for nineteen of the individual models and at a level of 0.05 for an additional three individual models. The analysis has established that quantity surveying, local authorities, and contracting type organisations have a lower frequency of model incidence in-use than multi-disciplinary and project management types of organisations. Although that statistically significant relationship was very weak it has been shown that it was unlikely to have arisen by chance. Therefore, it could be confidently expected that a relationship of that size held in the population of quantity surveying organisations in England

4.2.3 Quantity surveying / multi-disciplinary / project management types of organisation and model incidence in-use

There was a noticeable bias in the types of organisations into which respondents classified themselves. Table 3.4 showed that 90.1% of the organisations that responded to the survey classified themselves as being in either quantity surveying, multi-disciplinary, or project management type organisations.

Therefore, it was resolved to manipulate the data generated by the survey in order to investigate whether there were any statistically significant differences in the incidence in-use of building project price forecasting models between the principal organisational types indicated above.

Table 4.2 shows the results of the crosstabulation of the data related to organisational types indicated above and the frequency in-use of building project price forecasting models. A

visual inspection of the crosstabulated data presented in Table 4.2 indicated the following patterns in the percentage differences between actual and expected frequencies of model incidence in-use, namely,

- (i) organisations classified as being quantity surveying in nature had a consistently lower frequency of actual when compared to expected incidence in-use of all the models listed on the questionnaire form, and
- (ii) multi-disciplinary and project management types of organisations had a consistently higher frequency of actual when compared to expected incidence in-use of all the types of building project price forecasting models in-use.
- (iii) project management types of organisations had a consistently higher frequency of actual when compared to expected incidence in-use of all the types of building project price forecasting models in-use.

The crosstabulations for typical data sets that show the percentage differences between actual and expected model incidence in-use have been illustrated in Figs 4.3 and 4.4. Accordingly a chi-square test was applied as indicated above. The chi-square test applied to the data showed that the difference was significant at the 0.001 level, in sixteen of the twenty-four individual models across the following groups

traditional (excluding the approximate and detailed quantities methods), life-cycle, resource/process based, risk analysis, and value related models

Furthermore, the chi-square test indicated that there was a statistical difference in the frequency of model incidence in-use which was significant at the 0.05 level in an additional four of the individual models in the following groups,

knowledge based (excluding ELSIE), and the statistically based group (except for causal cost models)

The statistical analysis undertaken to investigate hypothesis (i) (a) has established that although there was a danger of a Type 1 error in the three results reported at the 0.05 level, the size of the chi-square statistics calculated across all of the newer non-traditional types of models together with the Cramer V statistic of 0.11 provided evidence of a very weak relationship between the quantity surveying, multi-disciplinary, and project management types of organisation and model incidence in-use that could not be caused by chance. Given such evidence the null hypothesis (i) (a), namely,

(i) (a) There was no difference between the data sets gathered from quantity surveying, multi-disciplinary, and project management types of

Fig 4.3 Organisational Type and Use of Model
Q.S. / Multi / Proj Man

Life Cycle Models

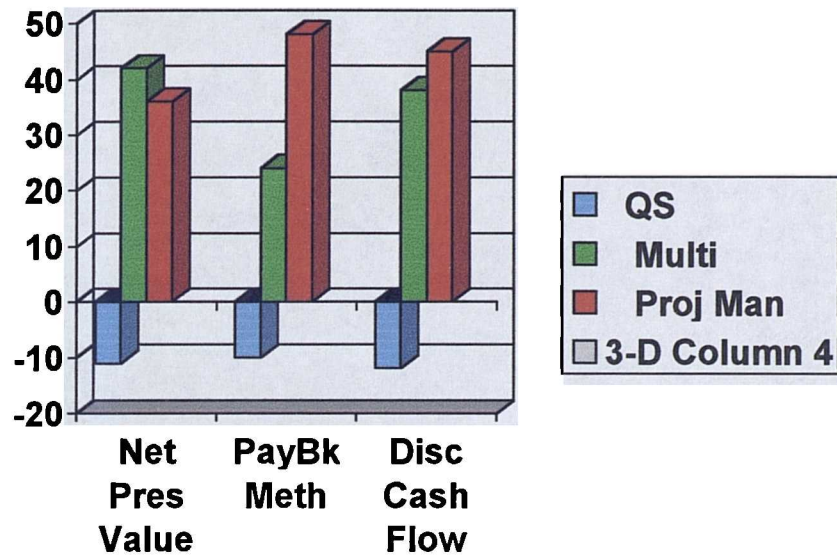
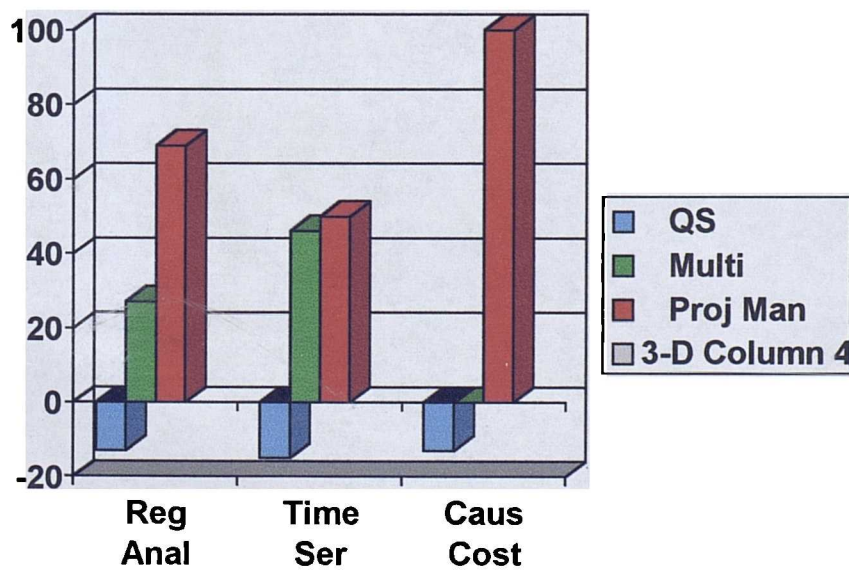


Fig 4.4 Organisational Type and Use of Model
Q.S. / Multi / Proj Man

Statistical Models



*organisation and the incidence in-use of building project price
forecasting models other than that caused by chance*

was rejected.

Therefore it was concluded that quantity surveying types of organisations had a lower frequency in model incidence in-use when compared to multi-disciplinary and project management types of organisation. It was found that such a relationship was statistically significant at a level of 0.001 for sixteen individual models and at a level of 0.05 for an additional four individual models. Although the strength of the statistically significant relationship was found to be very weak it was unlikely to have arisen by chance. Therefore, it could be confidently expected that a relationship of that size held in the population of quantity surveying, multi-disciplinary and project management types of organisations in England. This result indicated that the major type of organisation that responded to the survey, namely, the quantity surveying type of organisation had a lower frequency of non-traditional types of model incidence in-use. It was therefore decided to further investigate this organisational type in terms of the impact of differing levels of computing facilities and organisational size on the frequency of model incidence in-use

4.2.4 Quantity surveying organisations and model incidence in-use

Ratio of staff to computer workstation

Table 4.3 shows the results of the crosstabulation of the data related to quantity surveying organisations with differing ratios of staff to computer workstations and the frequency in-use of building project price forecasting models. A visual inspection of the crosstabulated data presented in Table 4.3 indicated the following patterns in the percentage differences between actual and expected frequencies of model incidence in-use, namely,

- (i) quantity surveying organisations with no computing facilities had a consistently lower frequency of actual when compared to expected incidence in-use of all the models listed on the questionnaire form, and
- (ii) quantity surveying organisations with a 1:1 ratio of staff to computing workstation had a consistently lower frequency of actual when compared to

expected incidence in-use of all types of building project price forecasting
models except for resource and process based models.

The crosstabulations for typical data sets that show the percentage differences between actual and expected model incidence in-use have been illustrated in Figs 4.5 and 4.6. Accordingly a chi-square test was applied as indicated above. A statistical difference in the frequency of model incidence in-use was detected between quantity surveying organisations with differing ratios of staff to computer workstation. This difference was significant at the 0.001 level, in thirteen of the twenty-four individual models across the following groups,

life-cycle cost models.

Furthermore, the chi-square test indicated that there was a statistical difference in the frequency of model incidence in-use which was significant at the 0.05 level in an additional seven of the individual models in the following groups,

traditional, statistical, knowledge based, risk, and value related models

The statistical analysis undertaken to investigate hypothesis (i) (b) has established that although there was a danger of a Type 1 error in the seven results reported at the 0.05 level, the size of the chi-square statistics calculated across all of the newer computerised types of models together with the Cramers V statistic of 0.17 provided evidence of a very weak relationship between the quantity surveying organisations with differing ratios of staff to workstation and model incidence in-use that could not be caused by chance. Given such evidence the null hypothesis (i) (b), namely,

*(i) (b) There was no difference between the data sets gathered from quantity
surveying organisations with differing ratios of staff to workstation and
the incidence in-use of building project price forecasting models other
than that caused by chance*

was rejected.

Therefore it was concluded that quantity surveying types of organisation with either a 1:1 ratio of staff to computer workstations or no computing facilities at all had a lower frequency in model incidence in-use when compared to other types of quantity surveying organisations.. It was found that such a relationship was statistically significant at a level of 0.001 for thirteen individual models and at a level of 0.05 for an additional seven individual models. Although the strength of this statistically significant relationship was found to be very weak it was unlikely to have arisen by chance. Therefore, it could be confidently expected that a

relationship of that size held in the population of quantity surveying organisations in England.

The results reported above were to be expected in terms of model incidence in-use and organisations that had no computing facilities at all. However, organisations with a staff to workstation ratio of 1:1 could have been expected to have had a higher frequency in model incidence in-use when compared to other quantity surveying organisations which had poorer staff to computer workstation ratios. Given the results of the statistical analysis reported above it was then decided to further analyse the data sets generated by quantity surveying organisations to see if size of organisation had a statistically significant affect on the incidence in-use of the building project price forecasting models available.

4.2.5 Size of quantity surveying organisation and model incidence in-use

Table 4.4 shows the results of the crosstabulation of the data related to different sized quantity surveying organisations and the frequency in-use of building project price forecasting models. A visual inspection of the crosstabulated data presented in Table 4.3 indicated the following patterns in the percentage differences between actual and expected frequencies of model incidence in-use, namely

- (i) quantity surveying organisations with only one member of staff engaged in the building project price forecasting process had a consistently lower frequency of actual when compared to expected incidence in-use of all the models listed on the questionnaire form, and
- (ii) quantity surveying organisations with between two and five members of staff engaged in the building project price forecasting process had a consistently lower frequency of actual when compared to expected incidence in-use of the statistical, knowledge based, resource /process based, risk, and value related models, and
- (iii) quantity organisations with eleven or more members of staff engaged in the building project price forecasting process had a consistently higher frequency

Fig 4.5 **Computing facility and use of models**
% Difference actual - expected count

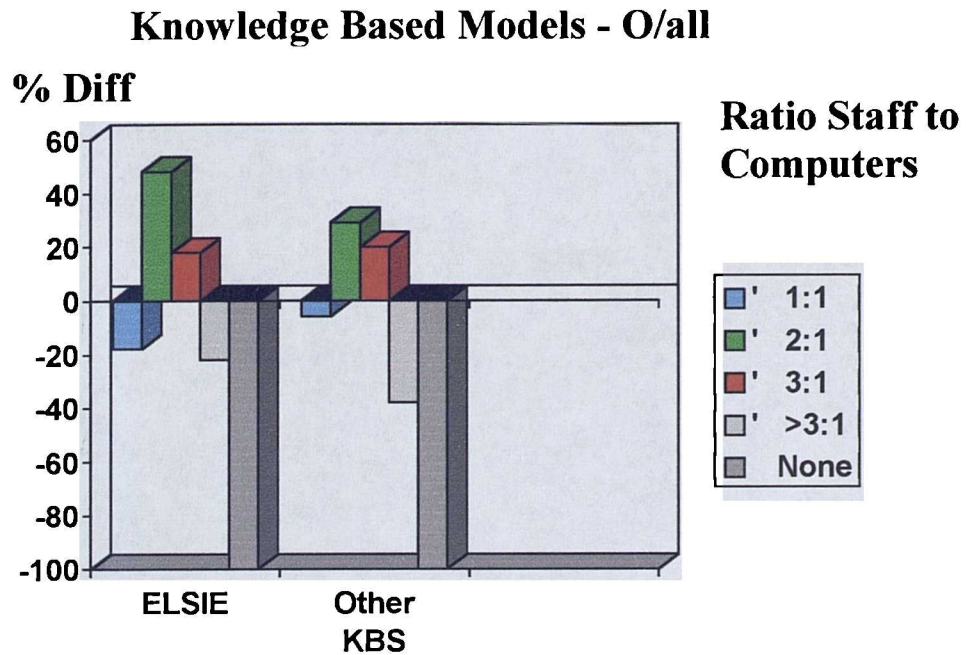
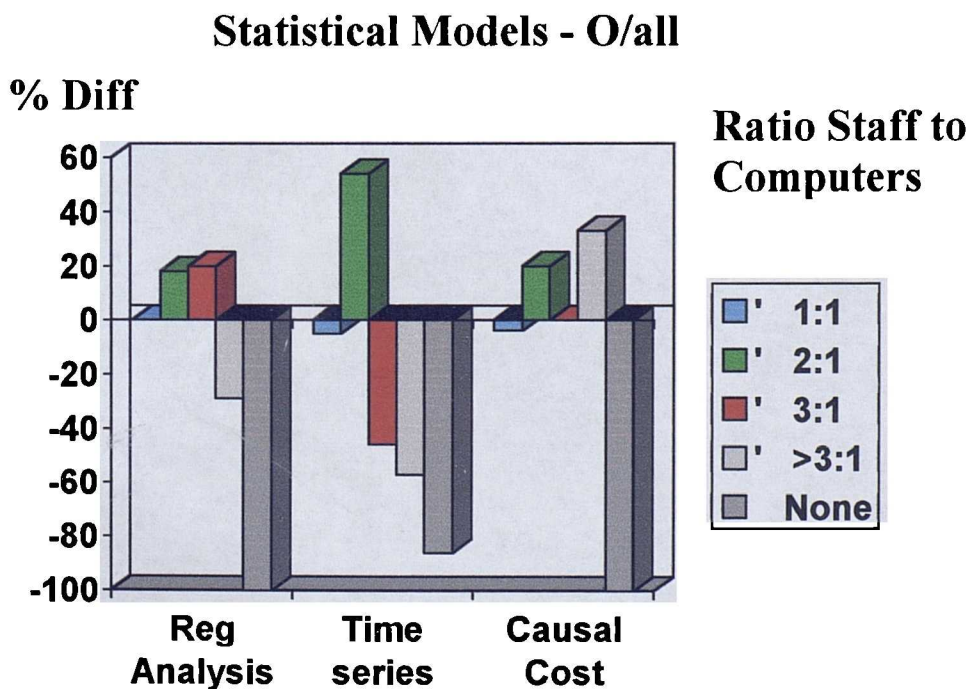


Fig 4.6 **Computing facility and use of models**
% Difference actual - expected count



of actual when compared to expected incidence in-use of all the newer computerised models listed on the questionnaire form.

Accordingly a chi-square test was applied as indicated above. A statistical difference in the frequency of model incidence in-use was detected between different sized quantity surveying organisations. This difference was significant at the 0.001 level, in twenty of the twenty-four individual models across the following groups,

statistical, knowledge based, life-cycle cost , risk, and value related models.

Furthermore, the chi-square test indicated that there was a statistical difference in the frequency of model incidence in-use which was significant at the 0.05 level in an additional three of the individual models in the following groups,

traditional (excluding the detailed quantities method) and resource/process based models,

The statistical analysis undertaken to investigate hypothesis (i) (c) has established that although there was a danger of a Type 1 error in the three results reported at the 0.05 level, the size of the chi-square statistics calculated across all of the newer computerised types of models together with a Cramers V statistic of 0.29 provided evidence of a weak relationship between the quantity surveying organisations with differing numbers of staff members involved in the building project price forecasting process and model incidence in-use that could not be caused by chance. Given such evidence the null hypothesis (i) (b), namely,

(i) (c) There was no difference between the data sets gathered from quantity surveying organisations of different sizes and the incidence in-use of building project price forecasting models other than that caused by chance

was rejected.

Therefore it was concluded that quantity surveying types of organisation with either one or between two and five members of staff engaged in the building project price forecasting process had a lower frequency in model incidence in-use when compared to other, larger sized quantity surveying type of organisations. It was found that such a relationship was statistically significant at a level of 0.001 for twenty individual models and at a level of 0.05 for an additional three individual models. Although the strength of this statistically significant relationship was found to be weak it has been shown that it was unlikely to have arisen by

chance. Therefore, it could be confidently expected that a relationship of that size held in the population of quantity surveying organisations in England.

4.2.6 Computing facilities within organisations and model incidence in-use

Table 4.5 shows the results of the crosstabulation of the data related to computing facilities and the frequency in-use of building project price forecasting models. A visual inspection of the crosstabulated data presented in Table 4.5 indicated the following patterns in the percentage differences between actual and expected frequencies of model incidence in-use, namely,

- (i) organisations with a 1:1 ratio of staff to computer workstations, and organisations with no computing facilities at all had a consistently lower frequency of actual when compared to expected incidence in-use of all the models listed on the questionnaire form, and
- (ii) organisations with a ratio of staff to computer workstations of more than 3:1 had a consistently lower frequency of actual when compared to expected incidence in-use of resource based, risk, and value related types of building project price forecasting models.

Accordingly a chi-square test was applied as indicated above. A statistical difference in the frequency of model incidence in-use was detected between organisations with differing ratios of staff to workstation. This difference was significant at the 0.001 level, in sixteen of the twenty-four individual models across the following groups,

life-cycle and risk analysis models.

Furthermore, the chi-square test indicated that there was a statistical difference in the frequency of model incidence in-use which was significant at the 0.05 level in an additional six of the individual models in the following groups,

traditional, statistical (except for causal cost models), knowledge based, resource based (except for construction cost simulator), and value related models

The statistical analysis undertaken to investigate hypothesis (ii) has established that although there was a danger of a Type 1 error in the six results reported at the 0.05 level, the size of the chi-square statistics calculated across the clear majority of the models listed together with a Cramers V statistic of 0.18 provided evidence of a very weak relationship between

organisational type and model incidence in-use that could not be caused by chance. Given such evidence the null hypothesis (ii), namely,

(ii) There was no difference between the data sets gathered from organisations with differing staff to computer workstation ratios and the incidence in-use of building project price forecasting models other than that caused by chance was rejected.

Therefore it was concluded that organisations with either a 1:1 ratio of staff to workstation or no computing facilities, as well those organisations with a ratio of more than 3:1 staff to workstation had a lower frequency of model incidence in-use when compared to other organisations. It was found that such a statistical relationship was significant at a level of 0.001 for sixteen individual models and at a level of 0.05 for an additional six individual models. Although the strength of this statistically significant relationship was found to be very weak it has been shown that it was unlikely to have arisen by chance. Therefore, it could be confidently expected that a relationship of that size held in the population of quantity surveying organisations in England.

The newer non-traditional building project price forecasting models require the use of some computing facilities in order to facilitate their operation. Therefore the results of the analysis in terms of those organisations without any computing facilities and those organisations with a staff to workstation ratio of 3:1 or more were worse than expected.

However, the crosstabulations and statistical analysis have also shown that those organisations that had a 1:1 ratio of staff to computer workstations had a consistently lower than expected level of frequency of model incidence in-use across all model types. This more unexpected result may be more related to organisational type and size in that small one person organisations, if they had a computer would have a 1:1 ratio of staff to workstations. It was suspected that such small sized organisations would have a lower than expected usage of models irrespective of their organisational type.

4.2.7 Organisation size and incidence in model use

Table 4.6 shows the results of the crosstabulation of the data related to organisational types and the frequency in-use of building project price forecasting models. A visual inspection of

the crosstabulated data presented in Table 4.6 indicated the following patterns in the percentage differences between actual and expected frequencies of model incidence in-use, namely,

- (i) organisations that engaged a single person in the building project price forecasting process had a consistently lower frequency of actual when compared to expected incidence in-use of all the models listed on the questionnaire form,
- (ii) organisations that engaged between two and five persons in the building project price forecasting process had a consistently lower frequency of actual when compared to expected incidence in-use of statistical, knowledge based, resource based, risk, and value related types of building project price forecasting models, and
- (iii) organisations that engaged between six and ten, and eleven or more persons in the building project price forecasting process had a consistently higher frequency of actual when compared to expected incidence in-use of all the types of building project price forecasting models.
- (iv) organisations that engaged more than eleven persons in the building project price forecasting process consistently had the highest frequency of actual when compared to expected incidence in-use of all the types of building project price forecasting models.

Accordingly a chi-square test was applied as indicated above. A statistical difference in the frequency of model incidence in-use was detected between differing sizes of organisations. This difference was significant at the 0.001 level, in twenty-two of the twenty-four individual models across the following groups,

traditional, statistical, knowledge based, life-cycle, risk analysis, and value related models.

Furthermore, the chi-square test indicated that there was a statistical difference in the frequency of model incidence in-use which was significant at the 0.01 level in an additional one individual model in the following group,

resource/process based (except for the construction cost simulator)

The statistical analysis undertaken to investigate hypothesis (iii) has established that the organisations with only one member of staff engaged in the building project price forecasting

process has a lower frequency in model incidence in-use when compared to other sized organisations. The size of the chi-square statistics calculated across the clear majority of the models listed together with the Cramers V statistic of 0.25 overall provided evidence of a weak relationship between organisational size and model incidence in-use that could not be caused by chance. Given such evidence the null hypothesis (iii), namely,

- (iii) There was no difference between organisations of differing size and the incidence in-use of building project price forecasting models other than that caused by chance.

was rejected.

Therefore, it was concluded that there was a statistically significant relationship between organisational types of different sizes and model incidence in-use. The results of the analysis have indicated that organisations with only one member of staff engaged in the building project price forecasting process have a less frequent than expected usage of the newer non-traditional building project price forecasting models than other organisations of different sizes.

Although that relationship was a statistically weak relationship it has been shown that it was unlikely to have arisen by chance. Therefore it could be confidently expected that a relationship of that size held in the population of quantity surveying organisations in England.

The results of the statistical analysis indicated that small sized organisations have a lower incidence in-use of all models used to forecast building project prices.

4.2.8 Organisations geographical location and model incidence in-use

Table 4.7 shows the results of the crosstabulation of the data related to organisational location and the frequency in-use of building project price forecasting models. This statistical analysis was undertaken to establish whether there was any regional bias in the incidence in use of particular building project price forecasting models. It was suspected that quantity surveying organisations located in the south of the England (including London) may have an increased tendency to make more use of the newer computer-based models because of the propensity for head offices of nation-wide organisations to be located there. A visual

inspection of the crosstabulated data presented in Table 4.7 indicated the following patterns in the percentage differences between actual and expected frequencies of model incidence in-use, namely,

- (i) organisations located in the northern region of England had a consistently lower frequency of actual when compared to expected incidence in-use of all the models listed on the questionnaire form except for those listed as knowledge based in nature.

Accordingly a chi-square test was applied as indicated above. A statistical difference in the frequency of model incidence in-use was detected between differing types of organisations. This difference was not significant at the 0.001 level for all twenty-four individual models tested. The most statistically significant result was that found in relation to the significant items model were $p < 0.05$, and the other knowledge based models in-use were $p < 0.04$. The organisations using other types of knowledge based models actually had a higher frequency in actual as compared to expected incidence in-use of this model type.

The statistical analysis undertaken to investigate hypothesis (iv) established that in general there was no evidence of a statistically significant relationship between organisational location and model incidence in-use. In terms of the two models reported above that did have relationship between location and incidence in-use which were reported at the 0.05 level there was also a danger of a Type 1 error. Given such evidence the null hypothesis (iv), namely,

- (iv) There was no difference between organisations located in the north and south of England and the incidence in-use of building project price forecasting models other than that caused by chance.

was not rejected.

Therefore, it was concluded that in general, there was no statistically significant relationship between organisation location and model incidence in-use. Given such results there was no need to apply Cramer's V test for strength of association.

4.3 Summary and reflections on the research process

4.3.1 Summary of main findings

Data related to each of the main hypotheses (i) to (iv) listed above were subjected to statistical analysis in order to establish significant relationships. The nominal data were subjected to a chi-square test and any statistical relationship had its strength assessed by the determination of its Cramer's V statistic.

In general the analysis found statistically significant associations in the data related to each of the hypotheses at both the 0.001 and the 0.05 levels. The statistically significant associations identified were then subjected to a Cramer's V test for strength and it was generally found that only weak levels of association existed. Nevertheless, the strong statistical significance found has allowed the following conclusions to be drawn, in the confidence that relationships of the strength stated existed in the population of quantity surveying organisations in England in 1997, and were unlikely to have arisen by chance, namely,

Organisational type and model incidence in-use - hypotheses (i), (i)(a), (i)(b), and (i)(c)

The following results were statistically significant at levels between $p < 0.001$ and $p < 0.05$ but had only weak levels of strength (Cramer's V between 0.10-0.40) in the data analysed,

- * quantity surveying, local authorities and contracting type organisations were found to have a lower frequency of model incidence in-use than multi-disciplinary and project management types of organisations

- * quantity surveying types of organisations had a lower frequency of model incidence in-use when compared to multi-disciplinary and project management types of organisation.

- * quantity surveying types of organisation with either a 1:1 ratio of staff to computer workstations or no computing facilities at all had a lower frequency of model incidence in-use when compared to other types of quantity surveying organisations.

- * quantity surveying types of organisation with either one or between two and five members of staff engaged in the building project price forecasting process had a lower frequency of model incidence in-use when compared to other, larger sized quantity surveying type of organisations

Computing facilities and model incidence in-use - hypothesis (ii)

The following results were statistically significant at levels between $p < 0.001$ and $p < 0.05$ but had only weak levels of strength (Cramer's V between 0.10-0.40) in the data analysed,

- * organisations with either a 1:1 ratio of staff to workstation or no computing facilities, as well those organisations with a ratio of more than 3:1 staff to workstation had a lower frequency of model incidence in-use when compared to other organisations with 2:1 or 3:1 ratios of staff to computer workstation

Organisational size and model incidence in-use - hypothesis (iii)

The following results were statistically significant at levels between $p < 0.001$ and $p < 0.05$ but had only weak levels of strength (Cramer's V between 0.10 - 0.40) in the data analysed,

- * organisations with only one member of staff engaged in the building project price forecasting process have a less frequent than expected usage of the newer more computerised building project price forecasting models than other organisations of different sizes

Organisations geographical location and model incidence in-use - hypothesis (iv)

The following results were statistically significant at levels between $p < 0.001$ and $p < 0.05$ but had only weak levels of strength (Cramer's V between 0.10 - 0.40) in the data analysed,

- * organisations located in the north of England had no difference in their frequency of model incidence in-use than organisations located in the south of England (including London)

4.3.2 Implications of findings for further work

Creswell (1994, p.180) indicated that the research design adopted for the study was what he termed as being, '*a two-phased combined design*'. Phase one has mapped out the 'state of the art' in terms of building project price forecasting models that were in actual rather than theoretical use. In addition it has identified a number of contextual variables which have been shown to have an effect on the use of particular model types by construction professionals active in the field.

For instance, the survey results that have been analysed above have established that relationships between the contextual variables of organisational type, size, and level of computing facilities, existed and were statistically significant although weak in nature. However, DeVaus (1996, p.7) indicated that surveys '*could not adequately establish causal connections between variables*'. For instance, the statistical analysis that has been carried out above cannot determine whether, say, the newer non-traditional models were more used in larger sized non-quantity surveying type organisations because they were large sized or because they were non-quantity surveying practice in nature, or because of the newer non-traditional models themselves.

In addition DeVaus (1996,p.7) asserted that surveys were '*incapable of getting at the meaningful aspects of social action*'. The survey or 'macro' level data generated from phase one of the study did not provide any explanations of how or why construction professionals active in the field selected particular types of building project price forecasting models for use when formulating their advice for clients. The establishment of the context within which such professionals made their selection decisions was useful information that could only be generated as a result of further work of a more qualitative nature in phase two of the study

The next phase of the study addresses the identification of the general factors that affected the selection of types of building project price forecasting models or tools in order to gain a richer, deeper understanding of the dynamics of the process of non-traditional model selection. The results from phase one of the study provided an initial framework of

organisational type, size, and nature within which the more qualitative in-depth investigation of the actual model selection process could be executed.

The use of the results gained from an initial phase of inquiry as the framework or starting point for a subsequent or phase two of a study was what Creswell (1994, p.178) indicated as being one of the advantages of using a '*two-phased combined design*'. Such an approach also provided an opportunity for '*sequential triangulation*' to be developed in the study as a whole.

Fielding and Fielding (1986,p.27) indicated that approaches that sought to achieve methodological triangulation could provide a '*theoretical framework for the process being considered, or a validation of survey data, or an aid to the interpretation of the statistical relationships identified, or an aid in the deciphering of puzzling responses to the initial questions posed in phase one of a study*'. In terms of this thesis the next phase of the work was undertaken to

- * identify the general factors that affected the selection of types of models by construction professionals active in the field within the different contextual settings of organisational type, size, and nature

- * develop a theoretical framework within which the more significant selection factors could be modelled so that best practice in the field can be achieved by construction professionals within differing contextual settings

4.3.3 Reflections on the research process so far undertaken

The activities undertaken and reported on in this chapter resulted in skills being developed in the application of the Minitab10 statistical analysis software package. Prior to the development of such skills it was necessary to ensure that an understanding of the principles of statistical analysis was gained. The process of the research reported on in this chapter enabled a better understanding to be gained of the nature of quantitative data, its handling,

manipulation, and its application to one of the differing types of statistical tests that were available.

The use of standard statistical analysis packages greatly enhances the speed, accuracy, and reliability of the resulting statistical indicators. However, such advantages can be lost if the researcher fails to appreciate the purpose of the tests that are available. As a result of the research process involved with this section of the thesis an understanding was gained of how and why data needed to be analysed and skills were developed in the application of one of the most common of the statistical tests available, namely, the chi-square test. The amount of data that needed to be analysed caused some problems in finding and locating the most appropriate computer hardware and the research log kept for the study revealed that the acquisition of appropriate resources did cause some delay in the actual analysis of the data that were generated by the full population survey undertaken.

The process of setting hypotheses and testing the relevant data for evidence of any statistically significant relationships is at the core of the positivistic approach to research. The experience gained in undertaking the research reported on in this chapter ensured that an awareness of the strengths and limitations of such an approach were gained.

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Chapter 5

Model Selection Criteria and the Building Project Price Forecasting Process

5.1 Introduction

Section 3 of the study concerns itself with exploring the territory related to the selection of building project price forecasting models for use. This section builds on the 'state of the art' previously established in section 2, by investigating, in more depth, the factors that cause practitioners to select one type of forecasting model from amongst the different types actually found to be in-use.

This chapter explores the general criteria thought by academics to be used by practitioners when they selected types of models for use. This exploration was carried out, initially, by reviewing available subject specific literature. The general model selection criteria that were identified were then confirmed and extended by considering model selection criteria identified in literature related to more general business forecasting. Having established the model selection criteria, alleged by academics to be available for use the chapter then reports quantitatively based evidence gathered from practitioners on the actual criteria they used to select between the differing types of building project price forecasting models found to be in-use.

The chapter concludes by advancing a preliminary conceptual framework that sought to reflect the dynamics of the actual model selection process in building project price forecasting. Such a framework was used to develop an initial indicative proposition that facilitated the collection of richer, deeper, more qualitatively based data from practitioners in the field. Such data grounded in practitioners experiences would capture the dynamic of the model selection process within the differing organisational settings that were identified in Section 2 of the study, as being influential, in terms of the pricing models found to be in-use.

The first stage in the process indicated above was to consider the available subject related literature in order to identify the criteria that academics alleged were influential to practitioners involved in the selection of building project price forecasting models for use.

5.2 Subject-specific model selection criteria

Makridakis *et al* (1983, p.761) commented that they thought practitioners commonly evaluated differing forecasting models on a single criterion, namely, '*the perceived level of model output accuracy*'. However, they pointed out that accuracy could not be considered as the sole criterion of forecasting model selection as it was not necessarily the product of the model that was the factor that needed to be evaluated. Makridakis *et al* (1983) asserted that '*if a forecaster models a situation well in the face of uncertainty then there was reason to support the forecast regardless of accuracy*'. Thus, they alleged that it was the process by which the forecast was formulated that facilitated real quality decision making by the forecast users'.

This theme was taken up and addressed by Raftery (1984) in his Ph.D. study on building cost modelling performance.

Raftery (1984) identified different criteria that could be used when assessing the performance of certain cost models or tools, namely, the data, the data / model interface, the model attributes or ease of application, the interpretation of output, and the nature of the decision making process. Raftery (1984) indicated that the data referred to were the project design data (data) and the data needed by the actual model or tool (data / model interface). That is the interpretation adopted in this work notwithstanding that the phrase data / model interface now commonly relates to technology transfer issues that are currently being addressed in the late 1990's.

The criteria advanced by Raftery for model performance evaluation, although limited in their scope, provided a basis for an initial rudimentary technique or tool selection framework which is illustrated in Fig. 5.1. This diagram provides an indication of the main themes within this part of the study, namely, issues related to the differing models or tools currently in-use, i.e.

the modelling environment, and issues related to the application and interpretation of the forecasting model(s) and their output, i.e. *the decision making environment*. The nature, comprehensiveness, and inter-relationships between the sub-issues within each of the ‘text bins’ that make up the rudimentary framework, shown below, now needed to be explored within the available literature.

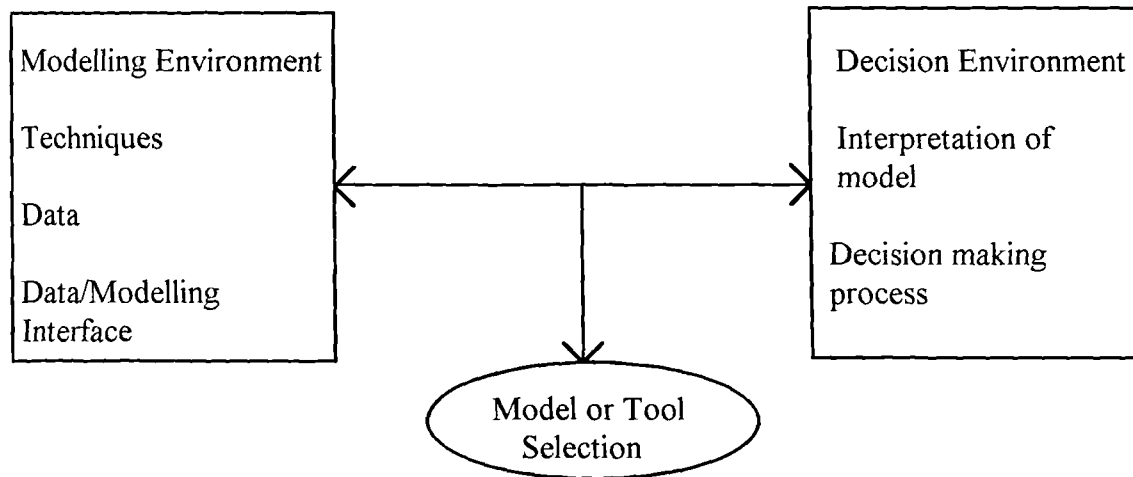


Fig 5.1 Rudimentary framework of building project price forecasting model selection process

Other theoretical studies by academics, such Taylor and Bowen (1987), Skitmore (1991), and Bowen (1995), as well as material within textbooks by Ferry and Brandon (1990), Gruneberg and Weight (1990), and Ashworth (1994), together with empirical work reported by Akintoye *et al* (1992), Fortune and Lees (1996), and Bowen and Edwards (1998) have between them identified a number of factors, which have been alleged to have an influence on practitioners’ involved in the selection of building project price forecasting models for use. The available material listed above was, initially, grouped together according to its academic strength and reviewed as follows,

Standard textbooks

Ferry and Brandon (1990, p.268) suggested that the following factors would affect the choice of building project price forecasting model to use, namely, ‘*the nature, size, shape, location, site characteristics, type of client, type of consultant, and the proposed quality levels related to the project under consideration*’.

Gruneberg and Weight (1990, p.45) in their textbook on feasibility studies for building projects asserted that the following factors needed to be taken into account by practitioners when they were considering the selection of forecasting methods for use, namely, the

'nature of the client in terms of, experience, competence, size and management structure; the appointment of the clients professional advisors in terms of, competence, attitude, degree of internal communication or co-ordination, financial constraints on the client, size, originality, complexity of the project, availability of relevant data, and experience of proposed building type; the perceived degree of risk associated with the project in terms of, external factors beyond the control of the design team'.

Ashworth (1994, p.77, and p.90) in his textbook on cost studies asserted that the factors that affected the use of forecasting techniques included,

'the amount of project information available, the amount and type of cost data available, the ease of model application, the familiarity of the user with the model, the speed of the model in use, the time available for the production of the price forecast, the experience of the forecaster, and the level of accuracy achieved by the model'.

The practically based literature reviewed in this section suggested an overall total of twenty-six potential price model selection criteria. The following criteria have been suggested as being influential by more than one source, namely, the nature of the client in terms of experience, competence, size and management structure; the type of consultant in terms of their competence, attitude, degree of internal communication, and experience of the proposed building type; amount of project related data, and the design period available.

The following were the sixteen separate factors that were alleged to have an influence on the selection of building project price forecasting models and which were identified from the literature so far reviewed, namely,

(1) nature of the project (2) size of the project, (3) the shape of the proposed project, (4) the location of the project, (5) the site characteristics of the project, (6) the type of the client, (7) the type of consultant, (8) the proposed quality of materials for the project, (9) the availability of project information, (10) the risks associated with the project, (11) the availability of cost data for the model, (12) the ease of model application, (13) the speed of the model in-use, (14) the time available for the forecast production, (15) the expertise/experience of the forecasters, (16) the accuracy required of the forecast

Gruneberg and Weight (1990) asserted that such groups of factors would have a combined effect on forecasters choosing models for use, namely, '*client related*, - (1),(4),(9),(14), *consultant related*, - (10),(14),(15),(16), and *project related* - (2),(3),(5),(6),(7),(8),(11), (12)'. This grouping or framework differs from the framework advanced by Raftery (1984) in that it identified sub-issues within the forecast decision environment, i.e. client and consultant related factors. This alternative framework suggested that Fig. 5.1 could only be seen as an initial conceptual model which had been constructed at a high level of abstraction and needed to be revised once the all the potential selection factors had been established.

Refereed academic papers - theoretically based work

Raftery (1984, p.171) in his doctoral thesis identified different criteria that he asserted could be used in the assessment of model performance, namely, '*data, data/model interface, interpretation of output, and the nature of the decision making process*'. Raftery asserted that construction professionals could select the most appropriate model for use on their future projects by assessing model performance on past projects, in terms of the criteria listed above.

Taylor and Bowen (1987, p.26) in their refereed journal paper on forecasting techniques and their applications asserted that the use of any technique was dependent on factors such as, '*the nature of the forecast being made, the time horizons, the nature and availability of input data, and resources available for the purpose*'. Taylor and Bowen (1987) went on to state that an ideal forecasting technique should also be '*responsive to changing environmental and technological conditions, and that users should be knowledgeable of and sensitive to the relative accuracy achieved by models in-use*'

Skitmore (1991, p.288) in the conclusion of his refereed conference paper entitled 'Which Estimating Technique' suggested that by considering '*the type of project, the level of information available, and the feedback system used*', it was theoretically feasible to predict which technique would give the best figure in terms of the price forecast required by a client.

Bowen (1995, p.30, and p.33) in a refereed RICS research report that offered a communication-based analysis of the theory of price planning and price control, set out factors that he felt would affect the choice of a particular price forecasting model for use,

namely, *'the amount of design information available, the informational needs of the model, and the interpretation of the model's output'*.

The literature reviewed in this section revealed an overall total of sixteen potential price model selection criteria. The following factors were suggested as being influential by more than one source, namely, *'the nature of the forecast, the nature of the model in terms of its ease of application, the nature of the model output, the level/amount of design data available, the type of data required by the model'*. The following were the eleven separate factors that were identified from the theoretically based literature so far reviewed,

(a) availability of design data, (b) data for the model, (c) the model's ease of application, (d) the interpretation of the model output, (e) the nature or purpose of the forecast itself, (f) the time horizon available, (g) the human resources available, (h) the flexibility of the model, (i) the level of forecast accuracy required, (j) the type of project, (k) the feedback system available,

It was apparent that some of criteria (a) - (k), which were identified above had already been identified as criteria (1) - (16) from within the standard textbooks available on the topic. Accordingly the following were the **additional** potential price model selection criteria identified from material published within refereed academic journals, namely,

(17) interpretation of model output, (18) nature or purpose of the forecast, (19) human resources available, (20) model flexibility in use, and (21) the feedback system available.

Refereed academic papers - empirically based work

Akintoye *et al.* (1992) undertook a small scale survey of quantity surveying practices that were operating in Lagos, Nigeria. As a result of the study it was asserted that the following factors could be considered as being influential in the collection and production of cost information for clients. The factors that were listed included, *time available, the nature of the project, availability of cost information, the level of accuracy and reliability required of the forecast, expected costs or frequency of model use, ease of use, and availability of project design data.* The factors listed were not given any weighting in terms of their alleged influence on practitioners.

A later study by Bowen and Edwards (1998) included an attempt to identify the more significant of a comparatively small number of selection criteria that were thought to influence practitioners in South Africa. The following were the identified criteria that

were included in the survey and they have been listed in descending order of their measured significance, *information available, time available, size of project, and client type*.

Fortune and Lees (1996, p.26) in their study on cost models in-use found evidence that the main reason for the non-use of potential cost models was '*the lack of understanding of the models*' by the practitioner producing the forecast.

This factor was again found to be influential in the survey results that were analysed and discussed in chapter 3 and 4 of this study. The nation-wide survey of quantity surveying organisations undertaken in section 2 - 'the state of the art' of this thesis established once again that lack of model understanding was an issue that prevented many practitioners from selecting particular models for use. For instance, it was found that lack of understanding was a significant factor affecting the non-use of causal cost models (63.3%) and the construction cost simulator (63.7%). However, it was found that lack of model understanding was **not** the main barrier to use for all the other types of models found to be in-use. Other types of models were affected to some degree by the negative barrier of lack of model understanding but it was found that their selection for use was more affected by other more positive factors as well.

Fortune and Lees (1996) work did not gather data on other potential reasons for the non-use of individual models but they speculated that factors which affected the non-use of models included,

'the inaccuracy and unreliability of the cost information produced by the model, the organisational capability of the model users in terms of the type of staff responsible for forecast production, and the operational capability of the model users in terms of access to computers'.

On further manipulation of the data gathered in their study Fortune and Lees (1996) were able to determine that '*the ability of model users to exercise judgement*' was also a factor that influenced the use of individual price forecasting models.

The literature reviewed in this section has so far revealed an overall total of sixteen potential price model selection criteria. The following factors were suggested as being influential by more than one source, namely, '*the level/amount of design data available, and the time*'

available for the forecast preparation'. Accordingly, the following were the fourteen separate factors that were identified from the empirically based literature based so far reviewed,

(i) the time available for the forecast preparation, (ii) the nature of the project, (iii) the availability of cost data, (iv) the level of accuracy required, (v) the expected frequency of model use, (vi) model ease of application, (vii) availability of project design data, (viii) the size of the project, (ix) the client type, (x) the lack of model understanding, (xi) the accuracy of the model output, (xii) the organisations human resources, (xiii) the extent of computer resources within an organisation, (xiv) the extent of judgement required in the use of the model

It was apparent that some of criteria (i) - (xiv), which were identified above, had already been listed within criteria (1) - (21) that had been identified from material published within the standard textbooks and theoretical literature available on the topic. Accordingly, the following were the additional potential price model selection criteria identified by the empirically based material published within refereed academic journals, namely,

(22) expected frequency/cost of model use, (23) lack of model understanding, (24) ability to exercise judgement, and (25) extent of computer resources available

The work reviewed above has indicated some limited consensus on the identification of potential model selection criteria. However, the literature reviewed also revealed a general reluctance to identify those criteria that have been more influential than others in the selection of types of building project price models or tools by practitioners. The empirical work by Bowen and Edwards (1998) was carried out at the same time that this work was being executed and it gathered quantitative data on a less comprehensive list of potential model selection factors from relatively few practitioners in South Africa.

Given the nature, size, and location of Bowen and Edwards (1998) work it did not produce results that could be generalised to the population of quantity surveying organisations operating in England. Therefore, at the time that this stage of the study was started there had been no empirically based work reported that had attempted to either confirm the relevance of **all** the (1) - (25) selection criteria identified above from the different types of subject specific literature, or ranked the identified criteria for their relative importance.

Prior to undertaking such a confirmatory study it was decided to expand the literature reviewed to include material related to general business theory in order to investigate whether

material in this wider domain would confirm and / or expand the number of potential model or tool selection criteria identified above.

5.3 General business forecasting model selection criteria

A review of work by Chambers and Mullick (1971), Chambers *et al* (1974), Milne (1975), Sullivan and Claycombe (1977), Fildes and Howell (1979), Makridakis *et al* (1983), and Lancaster and Lomas (1985), as well as material reporting empirically based studies by Wheelwright and Clarke (1976), Fildes and Lusk (1984), Mentzer and Cox (1984), Sparkes and McHugh (1984), and Mentzer and Khan (1995) provided an insight into the competing that were thought to influence general business forecasting model selection. The overall results gained from this review of literature within the general business domain was that it had established a more mature understanding of the different factors thought to affect the selection of their particular forecasting models. It was noticeable that several empirical studies had been undertaken which sought to rank the relevant model selection criteria for their importance. It was therefore decided to identify the influential model selection criteria found within general business forecasting in order to evaluate their appropriateness within the building project price forecasting model selection process.

Accuracy or amount of acceptable error in a forecast was identified as a selection criteria by each of the studies cited above. Makridakis *et al* (1983, p.113) in their textbook on forecasting methods identified factors suspected as affecting the use of individual forecasting models as being, '*the risks / uncertainties of the budget figure itself, the design period, and the prevailing market conditions*'. Other criteria that were identified in the literature quoted above have been listed below in descending order of popularity in terms of the numbers of citations amongst the sources indicated and included,

data available, cost/frequency of using a forecasting model, the experience of the forecaster, ease of forecasting model application, the understanding of the model, the forecasting organisation's technical capability, the nature of the client, the purpose/context of the forecasting problem, the time available for the price forecast to be formulated, the forecaster's education / training / awareness, and the nature of the manager / forecasters interaction or relationship

Of the selection criteria identified above the following,

(26) the prevailing market conditions, (27) the nature of the manager / forecasters relationship

had not been identified in the subject specific literature reviewed in section 5.2 above and so were considered as **additional** potential model selection criteria.

Empirical studies undertaken by Dalrymple (1975) and Wheelwright and Clarke (1976) sought to identify the important variables used in the selection of general business forecasting models. Those studies identified that the general business forecasting models used in practice at that time depended upon the stage of development that the business organisation viewed itself as having achieved. This factor has been more recently developed in the work of Pedler *et al* (1997) who have now advanced the concept of the 'learning company'. Therefore a further factor namely,

(28) the stage of learning that a forecasters organisation sees itself as attaining

was listed as an **additional** model selection criteria.

The potential model selection criteria identified in the literature reviewed above have been listed in Table 5.1. The table shows the identity and source material for each of the potential model selection criteria that have been identified.

Therefore, Table 5.1 showed that there was some limited consensus in the subject specific and more general business related literature cited above on the factors that were thought to be influential in the selection of building price models by practitioners. The four main types of information sources quoted above have identified a total of twenty-eight separate factors that were suspected as being influential in the type of building project price forecasting model or tool selected for use.

Table 5.1 indicated that of the potential criteria listed only three, namely, (14) time for forecast production, (15) experience of the forecaster, and (16) level of accuracy to be achieved were cited across all four types of information source and could therefore be considered as being seen as consistently significant. A total of fourteen separate potential selection criteria were supported by only one of the types of information source cited above. A further three potential selection criteria, namely, (26) the prevailing market conditions, (27)

internal organisation relationships, and (28) the stage of awareness of the organisation itself, were only identified within material cited that was related to general business forecasting.

Table 5.1 Potential selection criteria identified from across literature sources

Nr	Selection Criteria	Subject	Specific	General	Business
		Texts	Academe	Texts	Academe
1	Nature of the project	■ ■	● ● ●		
2	Size of the project	■			
3	Shape of the project	■			
4	Location of the project	■			
5	Site characteristics	■			
6	Type of client	■ ■		■	●
7	Type of consultant	■ ■			
8	Quality of materials	■			
9	Available project data	■ ■	● ● ●	■	
10	Risks assoc with project	■	●	■	
11	Available cost data	■	● ● ●		
12	Ease of model application	■		■	●
13	Speed of model in-use	■			
14	Time for forecast product	■	●	■	●
15	Experience of forecasters	■	●	■	●
16	Accuracy of model output	■	●	■	●
17	Interpret model output		●		●
18	Purpose of forecast		● ●	■	
19	Human resources needed		●		
20	Model flexibility in use		●		
21	Feedback from past proj		●		
22	Frequency/cost of model		●		●
23	Lack of model u/standing		●		
24	Able to use judgement		●		
25	Computers needed		●		
26	Prevailing mkt conditions			■ ■	●
27	Internal org relationships			■ ■	●
28	Stage of org awareness			■	

The material reviewed above indicated a limited consensus on the identification of some of the model selection criteria included in Table 5.1. The review did not reliably indicate which of the potential model selection criteria were the more significant for practitioners involved in

the building price forecasting process. The discovery of responses to questions related to finding out 'why', 'how', and 'in what circumstances' particular building project price forecasting models were selected for use could only be achieved by adopting a more qualitative approach to the work

5.4 Potential model selection criteria and their significance

Makridakis *et al* (1983) in their textbook on general business forecasting, as well as Ferry and Brandon (1991), and Ashworth (1994) in their textbooks on building project price forecasting, together with Mentzer and Cox (1984), and Mentzer and Khan (1995) in their empirically based academic studies on general business forecasting identified '*forecast accuracy*' as being the most important of the selection criteria listed above.

This assertion contrasted with Lancaster and Lomas (1985) and Fildes and Lusk (1984) who thought that criteria related to *the purpose of the forecast, and forecasters education / training / awareness of different models*, were respectively, the most influential of the identified model selection criteria.

The only empirically based subject specific work that had been undertaken at the time this study was being executed was that undertaken by Akintoye *et al* (1992). That study was a small scale investigation of the selection criteria used by practitioners in Lagos, Nigeria. However, this work did not attempt to rank any of the criteria they identified for their relative importance.

In general terms the literature reviewed revealed that there was a lack of agreement on the relative importance of the selection criteria thought to be the most influential in the selection of general business forecasting models. Building project price forecasting textbook sources indicated that they thought *accuracy of model output* was the most significant but not exclusive factor in building project price forecasting model selection. However, the conflicting opinion amongst the general business literature reviewed indicated that the assertion made in the subject specific textbooks, namely, that practitioners relied upon *accuracy of model output* as the single most influential selection criterion amongst a number of other competing and conflicting selection criteria, has been demonstrated as being naive in its nature.

In addition, the subject specific literature reviewed established that, at the time of the work within this part of the study was executed, there had been no empirically based work reported that had attempted to confirm the above findings in terms of actual model selection criteria used by practitioners involved in the building project price forecasting model selection process.

It was apparent that data needed to be gathered from practitioners in the field in order to provide evidence that could assist in the determination of the more important of the actual criteria in terms of determining which type of model or tool was to be selected for use.

5.5 Confirming and prioritising price forecasting model selection criteria

Chapter 3, section 3.6.11 of this study detailed the procedures adopted to contact construction professionals active in the field who were willing to co-operate in further studies on the topic.

Given the model selection issues revealed as being unresolved in the literature reviewed above, and the gap in the empirical work so far undertaken in connection with specific subject related literature, it was decided to confirm the identity of the building project price forecasting model selection criteria established above and suspected as being in-use by collecting quantitatively based data from practitioners active in the field.

In addition to finding out what were the factors used by practitioners actually involved in the building project price forecasting model selection process, it was also decided to gather data that would provide quantitative evidence of which model selection criteria were perceived by practitioners as being more important than others.

Therefore, it was resolved to conduct a quantitatively based study with building project price forecasters who were situated in England and who had volunteered to be involved in further follow-up work as a result of the previously reported nation-wide survey. Accordingly, a sample frame was determined that comprised the one hundred and sixty

seven practitioner organisations out of the one thousand two hundred and ninety-six organisations (12.9%) that had responded to the nation-wide survey.

A measuring instrument, based on the criteria (1)-(28) identified above and listed in Table 5.1 was prepared. The measuring instrument was designed, pre-tested, piloted, and distributed, together with an appropriate cover letter, in accordance with the good practice procedures detailed in chapter 3, section 3.4.1 and 3.4.2 of this study.

Each subject was asked to score each of the selection criteria indicated in Table 5.1 for their relative importance on a scale that ranged from 1 (low) to 5 (high). In addition the questionnaire form asked them to indicate any other selection criteria that they used but had not been detailed on the form.

An overall response rate of 58.2% was obtained. It was decided that this was a satisfactory response rate given that this quantitative study was carried out as a confirmatory exercise. The exercise was carried out to establish the identity and relative importance of each of the building project price forecasting model selection factors that had been identified from the available literature. There were no responses which indicated that there were any other selection criteria in-use but not listed on the form.

The results of the survey have been summarised in Table 5.4. Given the biased nature of the survey sample frame the results cannot be considered as being representative of the entire population of practitioner organisations in England. An analysis of the respondents to the survey in terms of the types and sizes of their organisations has been illustrated in Table 5.2 and 5.3.

Table 5.2 and 5.3 have shown that the profile of organisations that responded to the survey on criteria used in the selection building project price forecasting models for use was broadly similar to the profile of respondents in the nation-wide population survey reported on in chapter 3. The statistical analysis of the main survey data was detailed in chapter 4 of this work. That analysis revealed that in terms of the strength of relationship, size of organisation had more influence on models selected for use than had

Table 5.2 Organisational types responding to the survey on model selection criteria

Type of Organisation	Nr of Responses	% Total Responses	% Nation-wide Population Survey
Quantity surveying practice	57	60.0	71.0
Multi-disciplinary practice	19	20.0	10.1
Project management orgs	15	15.8	9.4
Others	4	4.2	9.5
Total	95	100.0	100.0
Did not respond to question	72		

Table 5.3 Organisational sizes responding to the survey on model selection criteria

Size of Organisation Nr of staff involved with strategic advice	Nr of Responses	% of Respondents	% of nation-wide Population Survey
1 only	21	22.1	25.8
2 - 5	39	41.1	45.7
6 - 10	20	21.1	17.5
11+	15	15.8	11.0
Total	95	100.0	100.0
Did not respond	72		

type of organisation. Table 5.3 shows that the profile of responses to the survey on selection criteria identity reflected the profile of size of organisations that responded to the main survey

Table 5.4 indicates the model selection criteria that the survey respondents confirmed as being relevant when they were engaged in the building project price forecasting model selection process. All twenty-eight selection criteria achieved positive scores above the neutral score of 2.5.

The selection criteria that were scored highest by the building project price forecasters that responded to the survey included,

(1) the availability of project related data, (2) the data needed by the model, (3) the forecasters understanding of the model, (4) the time available for the forecast production, (5) the project type or nature, and (6) the accuracy of the model output.

Table 5.1 indicates that of the top six criteria scored by building project price forecasters in the field only two were cited across all four information sources previously reviewed, namely,

(4) time available for the forecast production, and (6) the accuracy of the model output,

This result illustrates the need for further empirical data to be gathered on the factors affecting the dynamic of the building project price forecasting model selection process. The results have demonstrated a lack of consensus between academics and practitioners situated in England on which were the more influential of the differing model selection criteria.

Bowen and Edwards (1998) published the results of a similar data collection exercise with a more limited number of building project price forecasters based in South Africa. The results of this work were published after the quantitative data related to this study were collected. Model selection criteria identified by Bowen and Edwards (1998, p.18) as being significant were,

(i) information available, (ii) the time available for the forecast, (iii) the size of the project, (iv) the cost of the project, (v) the type of client, and (vi) the client sophistication.

Table 5.4 - Model Selection Criteria scored for importance

<i>Nr</i>	<i>Potential Model Selection Criteria</i>	<i>Avg Score (1-5)</i>	<i>Std Dev</i>	<i>Model Env*</i>
1	Amount of project data available	4.32	0.82	A,B,C
2	Data needed for model	4.17	0.88	B,D
3	Forecasters understanding of the model	4.15	0.99	B
4	Time available for forecast preparation	4.11	0.88	A,D
5	Project type	4.04	1.13	A,B
6	Accuracy of model output	3.97	0.88	B,D
7	Forecasters experience of model in-use	3.87	0.92	B
8	Amount of judgement required for model use	3.79	1.08	B
9	Ease of interpreting model output	3.77	1.00	B
10	Amount of risk in project decisions	3.77	0.81	B
11	Ease of model application	3.63	0.93	B,D
12	Feedback from previous forecasts	3.58	0.90	C
13	Nature or purpose of the forecast	3.57	0.94	A
14	Speed of the model in use	3.56	0.86	D
15	Human resources required to operate model	3.38	0.88	C
16	Site characteristics of the project	3.36	1.25	-
17	Level of awareness of new models	3.29	0.95	C
18	Flexibility of model in use	3.28	0.85	D
19	Project size	3.25	1.13	-
20	Nature of the client	3.23	1.19	A
21	Market conditions	3.22	1.28	-
22	Cost of using model	3.19	1.05	D
23	Design consultants for the project	3.05	1.28	-
24	Quality levels required in the project	3.05	1.27	-
25	Availability of computers for use with model	3.04	1.11	C
26	Relationships between forecaster and manager	2.67	1.03	B,C
27	Anticipated shape of the project	2.65	1.25	-
28	Geographic location of the project	2.55	1.22	-

* This classification relates to the subjective allocation of criteria to the conceptual modelling environments shown in Fig.5.2

Table 5.4 and Table 5.1 indicates that there seems to be some agreement between this empirical study and the empirical work carried out by Bowen and Edwards (1998) in South Africa, as well as the literature reviewed that the following model selection criteria, namely,

(i) the amount of project related information, and (ii) the time available for the forecast to be produced

were significant.

Accordingly, the quantitative approach so far adopted to the identification of model selection criteria confirmed that the positive model selection criteria identified in the literature reviewed above were relevant and it has provided an indication of which of the differing positive model selection criteria were thought to be the more influential. However, the quantitative approach adopted did not provide data on how practitioners used the differing selection criteria to discriminate between the available types of building project price forecasting techniques in actual use.

Fildes and Howell (1979) identified that the difficulty facing the forecast preparer was that there was no theoretical basis on which to choose a forecasting model appropriate to a given situation. Therefore, it was the way in which the forecast preparer was influenced by the potential selection factors that now needed to be investigated and data grounded in forecasters experiences gathered.

The collection of such qualitative data would facilitate the development of a conceptual model selection framework that if adopted by practitioners in the field would enable better quality decisions to be made by clients of the building industry.

5.6 Modelling criteria utilised to select techniques for use

Miles and Hubermann (1994) indicated that the boundaries of a qualitative investigation should be established before an initial exploration of a phenomenon was commenced. Therefore it was necessary to expand and give more shape and form to the rudimentary text based framework illustrated in Fig. 5.1

The statistical analysis of the quantitative data collected and reported in chapter 4 of the study indicated that organisational issues affected the incidence-in-use of certain models. Following the cross-tabulation of data collected within that nation-wide survey it was

shown that both *organisational size and organisational type* influenced the incidence-in-use of certain models. In particular, it was found that respondents who categorised themselves as being within multi-disciplinary and project management type organisations with more than six members of staff engaged in the building project price advice process had a greater propensity to use the newer more computer-based forecasting models than did forecasters that were located in other organisations of differing type and smaller size.

It was suspected that organisational factors such as these would have an affect on the selection of potential building project price forecasting models used by practitioners in the field. Such factors together with the selection criteria identified and scored for importance as shown in Table 5.4 needed to be considered in order to re-focus the rudimentary framework advanced in Fig. 5.1.

In addition a preliminary subjective classification of the identified criteria was attempted. It sought to place each of the model selection criteria (1) - (28) within an influence 'field' or 'environment'. The influence 'fields' or 'environments' that have been advanced were related to the technique selection model advanced by Wheelwright and Clarke (1976) in relation to general business forecasting.

Wheelwright and Clarke's (1976) classification system had three categories, namely,

- (1) *user environment* - including criteria related to users level of forecasting knowledge and relationships between forecast users and forecast preparers,
- (2) *forecast production costs* - including criteria related to computer costs, data costs, and time costs of users and preparers, and
- (3) *problem specific criteria* - including issues related to time horizons, level of accuracy, and degree of management support.

Given the technological changes and increases in problem complexity that have occurred since Wheelwright and Clarke's classification system was advanced it can be seen that their suggested groupings of the differing model selection criteria now needed to be re-focused in order to facilitate their evaluation

Therefore, an attempt to group the identified criteria into a preliminary classification framework was undertaken. Each of the model selection criteria (1) - (28) were assigned within an influence 'field' or 'environment'. The influence or "environments" that have been advanced were related to Wheelwright and Clarke's (1976) original model but they have been expanded and re-focused. For instance Wheelwright and Clarke's 'environment' related to (2) *forecast production costs* was not considered to be such a major issue within the commercial organisations of the 1990's given the general use of automatic computerised information handling systems. In addition, Wheelwright and Clarke's 'environment' (3) *problem related issues*, was considered to be too vague given the differing project related issues likely to be encountered within the construction industry. Furthermore, the nation-wide survey that was carried out and reported on chapters 3 and 4 revealed that organisational issues such as size, type, and the availability computers had an effect on the building project price forecasting models selected for use.

Therefore an initial conceptual model was developed following a consideration of Wheelwright and Clarke's model and the rudimentary text based framework which was based on Raftery's (1984) theoretical work and advanced in Fig. 5.1. Fig. 5.2 illustrates this initial conceptual model which was given the following labels,

- * (A) *the forecast users environment*,
- * (B) *the forecast preparer's environment*,
- * (C) *the forecaster's organisational environment*,
- * (D) *the forecast model(s) environment*
- * (E) *the project characteristics environment*

Each of the model selection criteria identified and listed in Table 5.4 were then considered in turn in terms of their allocation within each of the 'environments' (A), (B), (C), (D), and (E) that made up the initial conceptual model selection framework.

Category (A) *the forecast users environment* - includes criteria related to the client, the data available, the time available for the forecast production, the type of project, the provision of feedback from past schemes and the client's understanding of the model's usage. Table 5.4 indicated that the following model selection criteria had been provisionally allocated to this influence environment namely, (1),(3),(4),(5),(12),(13), and (20).

Category **(B) *the forecast preparer's environment*** - includes criteria related to the use of the data available, the forecaster's understanding, experience and ease of use in terms of available models, the forecaster's assessment of accuracy of the model's output, the forecaster's assessment of the project type that the forecast is required for, the forecaster's use of judgment and the nature of the relationship between the forecaster and the forecaster's manager. Table 5.4 indicates that the following model selection criteria have been provisionally allocated to this environment, namely, (1),(2),(3),(5),(6),(7),(8),(9), (10),(11),(12),(13),and (26).

Category **(C) *the forecaster's organisational environment*** - includes criteria related to the resources available, the availability of cost data, the feedback system used, the availability of computers, the nature of the relationship between the forecaster and the manager and the organisation's own assessment of its stage of learning or development. Table 5.4 indicates that the following selection criteria have been provisionally allocated to this environment, namely, (1),(12),(15),(17),(25), and (26).

Category **(D) *the model's environment*** - includes criteria related to the data/model interface, the time available for the production of the forecast, the speed and costs of the model in action, the accuracy of the model's output and the model's responsiveness to change. Table 5.4 indicates that the following selection criteria have been provisionally allocated to this environment, namely, (2),(4),(11),(14),(18),and (22).

Table 5.4 indicates the initial categorisation of each of the model selection criteria that had been described above. Table 5.4 indicates that the following model selection criteria have not been allocated within any of the four "environments" (A), (B), (C), (D), namely, (16) site characteristics, (19) project size, (21) prevailing market conditions, (23) type of project consultants, (27) shape of the proposed project, and (28) the location of the proposed project. On reflection it was decided that the un-allocated criteria listed would vary from specific project to project and so should be shown as a separate grouping. it was decided to label this separate grouping as category **(E) the '*project characteristics environment*'** within the emerging initial conceptual model selection framework.

Table 5.4 also illustrated that some of the individual model selection criteria identified above have been allocated to more than one of the influence environments advanced. Fig 5.2 illustrates a view of the conflicting influence environments [(A) ,(B), (C), (D), and (E) above] that was developed as an initial framework following the subjective classification of the individual selection criteria revealed in the literature considered above.

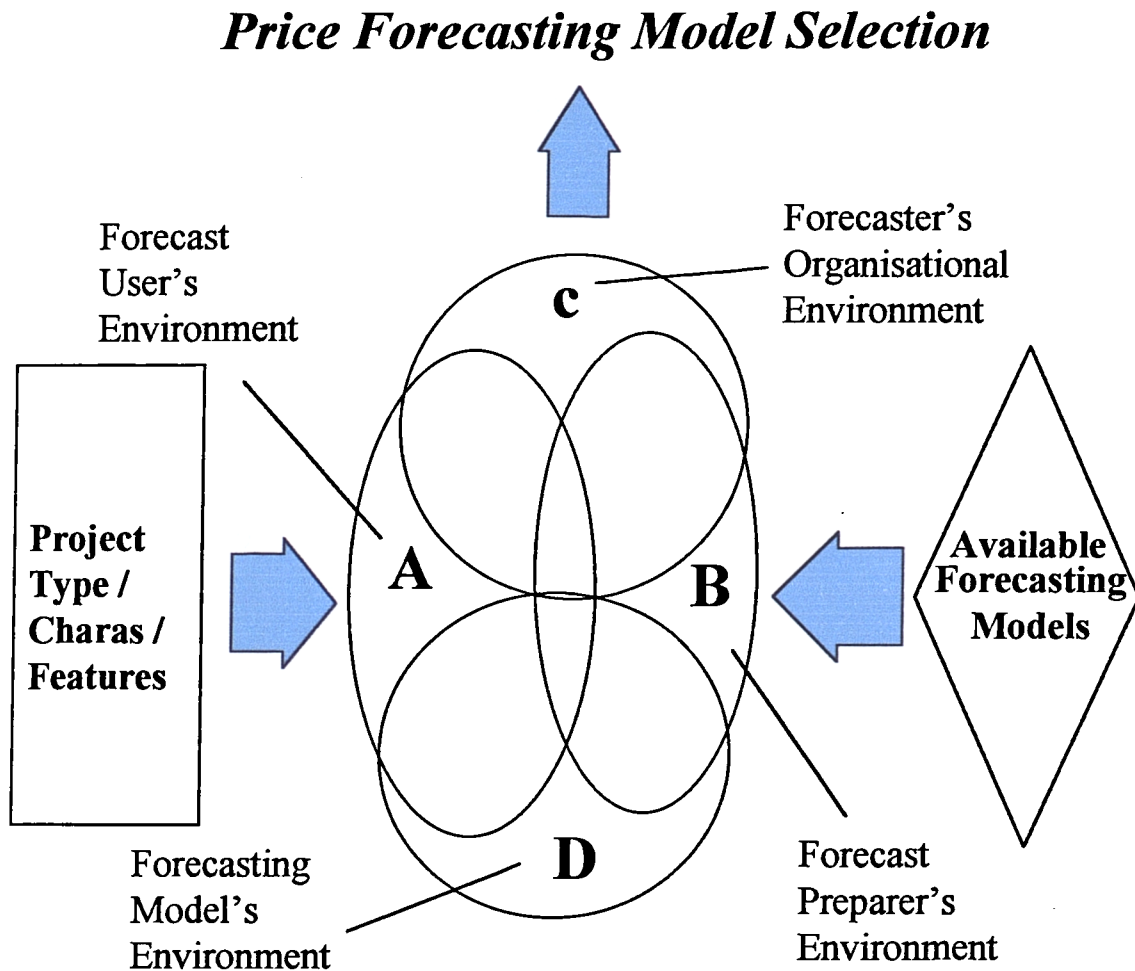


Fig 5.2 An expanded framework of the building project price forecasting model selection process

The classification of the model selection criteria indicated that the influence environments cannot be considered to be independent of each other. There was evidence of a blurring of the boundaries between one influence environment and another. The overlapping of the

influence environments and their respective criteria indicates a 'dynamic' interaction between the criteria that may change given differing project circumstances.

The confirmation of the environments that make up the conceptual framework shown in Fig. 5.2, and the initial classifications of the previously identified model selection criteria within each of the environments indicated in Table 5.4, together with the determination of the shape and size of each of the conceptual environments [(A), (B), (C), (D), and (E)] in terms of their impact on actual model selection decisions, now needed to be determined following the execution of an appropriate investigation amongst experts in the field

5.7. Summary and reflections on research process undertaken

5.7.1 Summary

This chapter reported the initial steps taken in the exploration of the selection processes related to the selection of building project price forecasting models by construction professionals active in the field.

A rudimentary text based framework was advanced in Fig. 5.1 as an initial aid to guide the exploration of the available subject specific literature. This review enabled a number of potential model selection criteria to be identified from both practically based and more academic sources. The existence and completeness of the potential model selection criteria was confirmed by reviewing other published material in general business forecasting and a comprehensive list of identified criteria was indicated in Table 5.1.

The process of grounding the existence and relevance of the potential model selection criteria in the experiences of practitioners involved in the selection of building project price forecasting models was then started. Initially it was resolved to collect quantitative data from a convenience sample of 167 price forecasters in the field in order for them to confirm, extend, and score for importance the factors alleged by academics to be influential in their choice of building project price forecasting model. Table 5.4 indicated the results of that data collection exercise.

Table 5.4 also indicated the initial classification of the model selection criteria that were found as a result of this quantitative work. The initial assignment of particular selection criteria to particular conceptual environment was made on the basis of intuition. Table 5.4 showed that some of the criteria listed have been allocated to more than one category as a result of this intuitive process. This process revealed the potential for the criteria listed on the measuring instrument to have more than one meaning and as such open to misinterpretation by the survey respondents. Such a potential indicated the limitations of the research approach taken to this activity and called for further work to be undertaken with practitioners in order to explore the full understanding of the terms listed as selection criteria and their impact on the process of building project price forecasting model selection.

The quantitative approach adopted for the establishment of the actual identity of the model selection criteria used by practitioners in the field confirmed that the positive model selection criteria identified in the literature reviewed above were still relevant and comprehensive. The claimed comprehensiveness of the model selection criteria was evidenced by,

- (i) the fact that there had been no further criteria suggested by the survey respondents, and
- (ii) the large number of criteria identified and included in the survey (28) as compared to the much smaller numbers of criteria included in other empirical studies by Bowen and Edwards (1998), who identified six criteria, and Akintoye *et al* (1992) who identified eight selection criteria

This quantitatively based work so far undertaken also provided an indication of which of the differing positive model selection criteria were thought to be the more influential, even though the results of the investigation were flawed as indicated above. A further disadvantage of the approach so far adopted was that it did not provide data on 'why' or 'how' or 'in what circumstances' practitioners used the differing selection criteria to discriminate between the available types of building project price forecasting models in actual use.

The quantitative approach so far adopted for this work mirrored the approach taken by other researchers, such as Bowen and Edwards, Akintoye, Raftery, and Skitmore. As a result, the 'research map' that represents the building project price forecasting process has now been well-defined in terms of identifying its major 'features'. What still remains to be explored is the extent and depth of the relationships between the differing model selection criteria, which may be likened to establishing the topography of the 'features' that have already been found on that research 'map'.

Such an exploration would clearly take the boundaries of knowledge, in terms of the factors involved in building project price forecasting model selection, beyond their present position. Such an exploration of new ground called for a change in research approach in order to develop an explanation or theory that could be used by others to optimise performance.

In the absence of any specific model selection theory it was decided to adapt and develop an initial conceptual framework that could be refined and re-focused in the light of the data gathered from practitioners involved in the process. An existing model of the selection process developed by Wheelwright and Clarke (1976) in the literature related to general business forecasting was considered, updated, and adapted to reflect the model selection process in the context of the construction industry. A subjective classification of the identified model selection criteria facilitated the development of an outline conceptual model which was illustrated in Fig. 5.2.

5.7.2 Implications for further work

The work undertaken above has indicated that there was a lack of theory related to the process of building project price forecasting model selection. The work undertaken also established that there were a number of competing and conflicting factors affecting the building project price forecasting model selection process. It was now necessary to determine a strategy that would facilitate an exploration of the dynamics involved. Such an exploration would require the use of a more qualitative research approach in order to establish the identity and strength of emergent relationships and patterns of influential selection criteria within data gathered from practitioners. The reliable establishment of regular patterns and relationships

between criteria would then allow a theory to be developed, that was grounded in practitioners experiences, and which sought to explain the process of building project price forecasting model selection.

Therefore, the way in which the forecast preparer was suspected as being influenced by the potential selection criteria needed to be expressed as an initial proposition or 'root definition', as defined by Checkland (1981). The development of such an initial proposition would aid the bounding of a further phase of investigations and give an initial shape to the collection of data, that were grounded in actual practitioner experience.

Such an investigation would,

- * confirm or otherwise the selection criteria identified in Table 5.1
- * confirm or otherwise the model selection criteria classifications and the appropriateness of the preliminary conceptual environments illustrated in Fig. 5.2

The drafting of the initial indicative proposition that would guide the start of such an investigation needed to take account of what had already been established as a result of the quantitatively based research so far undertaken. The initial indicator framework of conceptual relationships illustrated in Fig 5.2 showed that factors related to organisational setting as well as factors related to particular selection criteria affected practitioners involved in the building project price forecasting model selection process.

The individual selection criteria were listed in Table 5.4 prior to their subsequent grouping into five separate conceptual environments, namely (a) the forecast user's environment, (b) the forecast preparer's environment, (c) the forecasting organisation's environment (d) the forecast model's environment, and (e) the project characteristics environment. The interrelationships between the differing conceptual environments were illustrated in Fig. 5.2. Fig 5.2 was developed intuitively as a representation of what was understood to be the building project price forecasting model selection process. The collection and analysis of data grounded in practitioners experience will unravel the relationships between the differing conceptual environments and enable them to become more distinct. The development of a

sharper focus to the relationships between the selection criteria represented in Fig. 5.2 would enable their modelling to be of use to other practitioners in the field.

Factors related to the nature of the forecasting organisation itself had been identified as having an influence on the model or tool selection process as a result of the statistical analysis of the quantitative data collected via the nation-wide survey of models in-use that was reported in phase one of this work. Such factors were found to relate to issues such as organisational size, type, and ratio of staff to personal computers. A further organisational factor related to the geographic location of the organisation was a factor which, although suspected, was not actually found to be a factor that influenced the incidence of particular models in-use.

This quantitatively based work allowed the following initial indicative proposition, as defined by Strauss and Corbin (1990), to be formed, namely,

'The selection of particular building project price forecasting models depended upon the interrelationship of (a) the forecast user's needs, (b) the forecast preparer's skills, (c) the forecasting organisations resources, (d) the forecast model's attributes, and factors related to (e) the proposed projects characteristics together with factors related to the forecasters situation in terms of organisational size, type, and ratio of staff to computers'

Strauss and Corbin (1990) stressed that such a well grounded indicative proposition that reflected the potential conceptual explanation of the process under investigation provided a focused starting point from which further investigations could be structured.

Such an exploration of real world experiences would facilitate the development of a conceptual model that represented the dynamics involved in the process of building project price forecasting model selection.

5.7.3 Reflections on the research process undertaken

The activities reported in this chapter have acted, on reflection, as a fulcrum for the work as a whole.

The material within the chapter has proved to be at the interface between the research processes involved in the 'mapping out' of the existing field of knowledge related to the building project price forecasting model selection process, and the needed exploration of previously 'unmapped' relationships between the conflicting selection criteria previously identified. As a result of this realisation a greater appreciation has been gained of the limitations related to the quantitative research paradigm.

The research approach adopted has enabled the potential model selection criteria that were located in previously published material to be identified and confirmed as still being relevant to the dynamics of the building project price forecasting model selection process. The research approach adopted enabled the criteria that were identified to be scored for their importance and as such corroborated the findings of other researchers in the field who had adopted similar approaches. However the research approach so far adopted did not provide any understanding of 'how' or 'why' the selection criteria were important or less important.

The realisation that the results of the study so far undertaken had only provided a limited understanding of the process being investigated was a useful learning process. It resulted in the further work being approached from another more qualitatively based paradigm. Paradoxically, the exploratory work now called for could not have been started without first 'mapping out' the features of the building project price forecasting process. The work executed in the earlier phases of the study had identified the main parameters of organisational and operational constraints which have been identified through statistical analysis as having an effect on the model selection process. What was now required was a research approach which allowed the features on the building project price forecasting map to be defined and the relationships measured.

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Chapter 6

The Emergence of a Concept of Model Selection

6.1 Introduction

The previous chapter acted as a fulcrum for the study in that it concluded the quantitative mapping out stage of the investigation and demonstrated the need to qualitatively explore the territory associated with the building project price forecasting process. The model selection criteria that had been firstly, identified from the review of relevant literature, and then secondly, scored for their relative importance by practitioners in the field, were used to form a preliminary conceptual framework. This preliminary framework was developed in order to facilitate the change in research approach that had been envisaged in the combined two-phase sequential research design adopted for this study (see chapter 3, section 3.2).

An exploration of the territory related to the dynamics of the model selection process would enable its elucidation to be generated. Such an explanation needed to consider why, how, and in what circumstances, practitioners in the field made use of the differing selection criteria to discriminate between the types of price forecasting models that were found to be in-use in the first quantitative phase of this study.

The initial sections of this chapter consider underlying philosophy, epistemology, and analytic processes appropriate for this discovery of 'why' and 'how' different types of models were selected for use, and 'in what circumstances' the model selections were made. The chapter then details the processes involved in the interpretative research work itself. The qualitative data generated from selected building project price forecasters in the field (interviewees 1-4) were analysed with the NUD*IST4 software package and then compared with the data already obtained via the quantitatively based research reported in the previous chapter. As a result, emergent model selection categories were identified that were grounded in practitioner's experiences.

The chapter concludes by advancing an initial propositional data-analysis-framework that reflected the emerging grounded model selection categories rather than the more abstract selection criteria that constituted the preliminary conceptual data-analysis-framework. The developing data-analysis framework was illustrated by an initial propositional model which was to be used to shape the collection and interpretation of further data from practitioners in the field.

A consideration of the intellectual principles underpinning this elucidation of the process of building project price forecasting model selection was seen as being an appropriate first step.

6.1.1 Epistemological issues

Generally

The rationale for the two-phased combined research design that was adopted for this work was set out in Chapter 3, Section 3.2. The design adopted called for an initial stage that mapped out the building project price forecasting models actually in-use and their theoretical selection criteria. This was achieved by adopting a positivist viewpoint that posited hypotheses and analysed collected data in order to determine whether the hypotheses could either be supported or not supported.

This second, more qualitative phase of the combined research design now sought to discover an explanation of how, why, and in what circumstances practitioners in the field selected particular types of building project price forecasting models for use. This second, or sequential, phase of the research design was therefore given its shape and direction by the results generated from the first round of quantitative work.

Miller and Crabtree (1998), in their discussion on the relative merits of differing research designs confirmed that combined or sequential designs were useful in allowing the results of one part of the study to develop the form of the following section. The appropriateness of such an approach was illustrated by Miller and Crabtree (1998, p.300) when they cited a medical study undertaken by Snadden and Brown (1991). That study had used a sequential

combined research design that made use of an initial survey of patients in order to identify a sampling frame of subjects that had particular characteristics from which they were able to select a purposeful sample for further investigation. They reported that the subsequent investigation made use of a more interpretative approach to data analysis.

Patten (1987) also supported the use of sequential research designs that sought to use qualitative approaches in order to build upon quantitative work that had firstly mapped out the field. Patten (1987, p.38) pointed out that the quantitative results of such studies were used to identify the parameters of the follow-on study and gave it a clear focus. Patten maintained that such an approach would allow the follow-on study to *'put flesh on the bones of the initial quantitative results by getting close to the people and situations being studied in order to gain insights into the realities and minutiae of their daily life'*.

This investigation now needed to consider the methods by which it could *'flesh out the bones'* of the factors involved in the building price forecasting model selection process. It was recognised that quantitative approaches on their own would not achieve the required insights into the model selection process that were necessary. An exploratory inquiry in which an attempt was made to describe and analyse the dynamics of the model selection process needed to gain insights from *'the point of view of those involved in such processes'*. Such an approach was described by Bryman (1994, p.46) as possessing the core characteristics of an interpretative type of qualitative inquiry.

Maykut and Morehouse (1994, p.7) saw all qualitative research as being based on a *'phenomenological position'* in which *'peoples words and actions were examined from that persons point of view in order to gain insights into the process being investigated'*. However, Bryman (1994, p.50) pointed out that there were other intellectual undercurrents as well as *'phenomenology'* within the broad range of qualitative type inquiries. Such philosophical positions have been drawn from across academic disciplines such as sociology, anthropology, and psychology.

The philosophies underpinning such disciplines were identified by Bryman (1994, p.55,60) as being, namely, '*symbolic interactionism*', in which social life was seen as '*an unfolding process in which the individual interpreted his or her environment and acted on the basis of that interpretation*'; '*naturalism*' which sought to treat any phenomena under investigation in its '*natural context and surroundings*'; and '*ethogenics*' which sought to embrace the principles of '*good science in the examination of the genesis of human social actions*'. Miller and Dingwall (1997, p.28) asserted that theoretical schools or traditions such as '*symbolic interactionism, ethnomethodology, and phenomenology*', should be distinguished from other more general approaches to research such as '*ethnography*', or strategies of research design and analysis such as '*grounded theory*'.

Research problem and epistemological position

The research problem at the core of this phase of the study addresses complex issues relating to the factors affecting the selection of building project price forecasting tools. It needs to develop an understanding of how building project price forecasters, (i) interpret the service required of them, (ii) evaluate options, in order to (iii) select appropriate tools to undertake the service required. In order to develop a complete understanding of such a complex issue the researcher needed to gain insights from the building project price forecasters point of view via the words they use to describe the model selection process.

Previous work in the area, notably by Akintoye *et al* (1992), and Bowen and Edwards (1998), had been approached from a positivist viewpoint. Their work had attempted to measure the importance or significance of a small number of the model selection criteria that were identified in chapter 5. Furthermore they had assumed that each criteria was acting in an independent manner on the building project price forecasting model selection process. Given the discussion above on differing epistemological standpoints it can be seen that any attempt to develop an understanding of such complex problems from a positivist standpoint could only produce limited results. Such an approach had been adopted and reported on in chapter 5 of this study, and as a result it was decided that further work from an interpretivist perspective was required.

Therefore, this phase of the study adopted an approach that drew upon phenomenology and social interaction as the philosophical positions most relevant to the problems being investigated. This multi-paradigmatic position reflected the pragmatic approach adopted within this study in particular, and construction management research in general. Its adoption was debated in terms of its relevance amongst the differing research methodological approaches in chapter 3, section 3.2 of this study.

Such an epistemological position was acknowledged by Miles and Huberman (1994, p.5) as being 'realistic' as they indicated that in methodological debates it was

'tempting to operate at the poles, but in the actual practice of empirical research, we believe that all of us are closer to the centre (and operate) with multiple overlaps ... The paradigms for conducting social research seem to be constantly shifting and as a result an increasing number of researchers see the world with ever more pragmatic, ecumenical eyes'.

Miles and Huberman (1994, p.5) asserted that qualitative research could be '*conducted in dozens of ways*'. For instance Tesch (1990, p.58) identified twenty-seven different '*brands*' of qualitative research approaches. Miles and Huberman (1994) identified three separate taxonomies of analysis methods that had been developed by Jacob (1987), Tesch (1990), and Wolcott (1992).

Tesch (1990, p.77) structured her taxonomy of qualitative research approaches from the point of view of the actual topic under consideration. Tesch's taxonomy had the following main classifications namely, '*the characteristics of language; the discovery of regularities; the comprehension of the meaning of text or action; and reflection*'. Tesch made clear that there were blurred edges between each of the main classifications that she identified, and that of them, the '*discovery of regularities, and the comprehension of actions*' employed the most '*homogeneous of the analysis processes available*'.

Miller and Dingwall (1994, p.30) pointed out that in order to identify an appropriate approach to a qualitative style of study it was necessary to fully identify the epistemological underpinnings of the proposed work.

This study started with the premise that the process of building project price forecasting model selection could be understood by asking questions about it of persons experienced in that selection process so that they could convey their understanding of that process by their own descriptions and insights. The researcher could then take an interactionist approach, that sought to distill the views of the persons experienced in that model selection process and to place them within a more general conceptual framework. This approach then sought to place the framework in a more general context which in turn would enable the development of appropriate generalisations.

Given the above epistemology for this stage of the work, it was decided that this particular research problem, namely, the discovery of a set of logically interrelated propositions that sought to explain the dynamics of the building project price forecasting model selection process, was a topic that could fall under more than one of Tesch's taxonomical classifications. For instance, the use and common interpretation of language between the givers and the receivers of building project price forecast information formed the basis of interaction between the different players involved. According to Tesch's (1990, p.62) classification such a research interest called for an analysis of how *'human beings made sense of their interactions with each other'*, which she asserted could be achieved using ethnomethodological approaches.

At the same time the research problem being investigated required the *'identification, categorisation, and exploration of the connections between distinct elements of a process'* as well as the *'discerning of patterns of behaviour in terms of conceptualisation and culture'*. The characteristics of such an investigation reflected what Loosemore (1999, p.11) indicated were the characteristics of symbolic interactionism, in which *'meaning is socially constructed'*. Tesch (1990, p.63) and Loosemore (1999, p.11) asserted that investigations that had their philosophical underpinnings in phenomenology and symbolic interactionism were best executed by making use of either ethnographical or grounded theory like approaches

Jacob (1987, p.10) defined ethnography in sociological type studies as being concerned with *'the description and analysis of all or part of a culture or community by describing the practices and beliefs of the group being studied and showing how the various parts of the process contributed to the cognitive map of the culture under investigation'*. Glaser and Strauss (1967, p.1) defined a grounded theory approach as one that *'sought to discover theory from data through the general method of constant comparative analysis of data emerging from the field'*.

Denzin and Lincoln (1998, p, 64), provided a rule of thumb heuristic to aid the determination of an appropriate choice of analytic approach to a research problem that concerned the *'elucidation of the dynamics of a phenomenon'*. In this case, the phenomena were the factors affecting the process of building project price forecasting model selection. They suggested that a problem that was only concerned with the identification of its nature was best obtained using *'ethnographical methods of participant observation'*. However, if the question under consideration concerned the explanation of an experience or process, such as in this case, then a *'grounded theory-like'* approach would be the most appropriate of the available strategies to adopt.

6.1.2 A grounded theory-like approach

Glaser and Strauss (1967, p.1) challenged the conventional approach to the collection and analysis of qualitative data when they first developed the concept of grounded theory. In particular they advanced the view that a *'systematic approach to the generation of data which was complemented by a naturalistic approach'* could be considered to be capable of developing a theory that was 'grounded' in its nature. Strauss and Corbin (1990, p.23) defined a grounded theory as one that was *'inductively derived from the study of the phenomenon that it represented and that it was discovered, developed, and provisionally verified through the systematic collection and analysis of data from the field that pertained to that problem'*.

This view was reinforced by Strauss and Corbin (1990, p.24) when they commented that a *'grounded theory-like approach'* was a qualitative research method that used a "systematic

set of procedures to develop an inductively derived 'grounded' set of relationships or theory about a phenomenon.

The phenomenon being considered within this study related to the discovery of relationships connected to the building project price forecasting model selection process. It was decided to adopt this grounded theory-like approach in order to benefit from the scientific rigour its adoption imposed on the data collection and data analysis processes. Strauss and Corbin (1990, p.57) indicated that the principal benefits from adopting the analytical procedures within a grounded theory-like approach included the following, *'the rigour necessary to ensure any relationships that were discovered were as a result of "good" science'*, and the ability to ground the emergent data in order to *'build the density, develop the sensitivity, and initiate the integration needed to generate a tightly woven, explanatory theory or set of relationships that closely approximates to the reality that it represents'*.

A further consequence of the adoption of this approach was the need for the processes of data collection and data analysis to be a closely related activity. The approach called for the data that was analysed to direct the collection of further data from practitioners in the field. Strauss and Corbin (1990) maintained that it was possible to establish conceptual relationships by the systematic exploration of potential linkages. This and other issues related to the interpretative research process itself now needed to be considered.

6.2 The interpretative research process

Having established the epistemological viewpoint for this more interpretative phase of the work and its approach within the overall research design which was set out in chapter 1, section 1.4, it was now necessary to consider the remaining issues related to the interpretative research process itself. Creswell (1994, p.146) set out a checklist of issues that needed to be considered before the fieldwork stage of a project was commenced. Such issues included, the consideration of data collection procedures, the identification of the theoretical sensitivity of the researcher, the rationale for the selection of participants, and the data analysis processes to be adopted.

6.2.1 Data collection procedures

Bryman (1992, p.44) identified four main types of data collection methods, namely, '*participant observation, interviews, life history, and group discussion methods*'. The principal method of data collection in most qualitative inquiries that adopted an ethnographic approach was identified by Creswell (1994, p.150) as *being 'participant observation'*. This method of data collection required the investigator to become physically immersed amongst the researched in order to experience the phenomenon as the researched experienced the phenomenon.

Miller and Dingwall (1997) indicated that participant observation called for the researcher to experience a prolonged period of exposure to the phenomenon under investigation. Miller and Dingwall (1997, p.61) asserted that it would then be possible to produce an in-depth account of the process under consideration following such exposure in the field. However, the main limitation with this proposed method of data collection was that it did not provide any insight into 'how' or 'why' particular types of price forecasting model were selected. Participant observation revealed nothing about what is going on inside the heads of the researched. Miller and Dingwall (1997, p.61) indicated that as a method of data collection it '*told us about the set of solutions that have been produced in response to a problem and not the process of the solution itself*'.

It was also recognised at the research design stage that the limited resources available to the study in terms of time, finances, and staff available for its execution would preclude participant observation as a feasible option for the data collection method adopted for this phase of the study.

In addition the preliminary studies undertaken in connection with the work indicated that the gatekeepers of potentially co-operative organisations were not willing to accede to requests for lengthy periods of interaction between their staff and the researcher undertaking the study. This was largely due to the lack of a culture of participative

research amongst many of the small and medium sized organisations that made up the population of quantity surveying organisations in England.

Similarly, it was inappropriate to use focus group interviews as the method of data collection due to the resources required to set up such opportunities. The data collection option actually adopted was the in-depth interview method. Creswell (1994, p.150) indicated that such interviews could be carried out on a '*face to face or telephone basis*'. Interviews conducted over the telephone or by electronic means have been found by others to be a very resource efficient means of effecting communication. However, it was decided to use '*face-to-face methods*' for this study in order to ensure that fuller understanding was achieved as a result of the communication process between the researcher and the researched. It was recognised that such an approach required financial assistance in order to facilitate its achievement, and so it was only adopted following a successful bid to the RICS Education Trust for additional resources.

The main limitation associated with the face-to-face interview method of data collection was that it relied upon the participants to be articulate. In addition, access had to be negotiated with the gatekeepers of the organisations in which building project price forecasters were located. Initial contact with typical organisations indicated that participant observation was not possible for the reasons set out above, however, such contacts did indicate that the gatekeepers of the organisations who returned the participant confirmation forms found the proposed face-to-face interview method of data collection to be more acceptable.

A further limitation of this method of data collection was seen to be the potential for bias due to the artificial nature of the interview situation itself. Therefore, it was decided to reduce that bias to a minimum by conducting each of the interviews with the practitioners in their own work place settings and at a time of their convenience. In addition a consistent agenda of topics for discussion was used for each group of interviewees.

It was also resolved to produce full transcriptions of each conversation, rather than notes or action minutes. It was recognised that this method of data capture would place an

additional administrative burden on the execution of the study. Nevertheless, it was decided to adopt this form of data recording in order to avoid the omission of any significant data from the subsequent analysis process. Also the decision at research design stage to use a computerised data analysis software package facilitated the use of full interview transcriptions. The use of such a data analysis package which adhered to the principles of protocol analysis provided an additional means by which rigour in the data analysis process could be evidenced. It was also necessary to use a qualitative data analysis package given the large amounts of data that were expected to be generated from the conversations between the researcher and the researched.

Accordingly, each participant was asked at the start of the interview whether they would object if the words they used in relation to the building project price forecasting model selection process, were tape-recorded. There was some initial hesitation amongst some of the informants due to their unfamiliarity with the research process. Some needed to be re-assured about the confidentiality of their data and the proposed data verification procedures. Following such re-assurances it was found possible to quickly establish rapport between the researcher and the researched. Ultimately each interviewee agreed to allow their conversations with the researcher to be tape-recorded.

Patten (1987, p.137) confirmed that the face-to-face tape recorded conversation between the researcher and the researched was the approach to data gathering to adopt as *'no matter what style of interviewing was used and no matter how carefully one words the interview questions, it all comes to naught if the interviewer fails to capture the actual words of the person being interviewed'*.

Readers note : The verified transcriptions of each of the conversations undertaken with practitioners 1 - 31 have been stored in the NUD*IST4 document files provided on the disc attached to the rear of this document

6.2.2 Theoretical sensitivity

Robson (1993,p.68) made clear that in a qualitatively based study the possibility of observer bias *'could cause problems of interpretation'*. In this study one of the major

potential sources of bias was the bias that the researcher brought to the interview situation. Strauss and Corbin (1990) made it clear that the potential for interview bias in qualitative work had to be addressed. Strauss and Corbin (1990) indicated that it was important for the researcher to set out, in an open manner, any past experience with the phenomenon under investigation.

The researcher in this study was a fellow of the Royal Institution of Chartered Surveyors and a corporate member of the Chartered Institute of Building. As such the researcher was a professionally qualified building project price forecaster who had eight years practical post qualification professional experience in the selection and use of building project price forecasting models. This practical experience of the phenomenon being investigated was gained in both small and large sized quantity surveying organisations that offered building project price forecasting services to a range of differing types of clients.

This familiarity with the topic, its context, and the work setting of the potential interviewees could be construed, from a positivist perspective, as allowing a bias to enter this data gathering phase of the study. However, Strauss and Corbin (1990, p.41) indicated that in a grounded theory-like approach the ability of the researcher to develop what they termed as '*theoretical sensitivity*' helped the researcher in the interpretation of the data that was collected and so assisted in the '*development of concepts that were dense, grounded, and well integrated*'.

This particular perspective on the potential of observer bias was initially developed in Glaser's (1978) work which challenged the idea that any research could be entirely bias free. Glaser suggested that in interpretative work the biases, values, and experiences of the researcher should be recognised and used to help develop well grounded conceptual theories. Strauss and Corbin (1990, p.42) made clear that they too saw this as a strength in an interpretative approach to a study in that it facilitated the theoretical understanding of the phenomenon under consideration.

Strauss and Corbin (1990, p.42) also asserted that this theoretical understanding was achieved by allowing the researcher with '*theoretical sensitivity*' to '*give added meaning to the data collected, by being able to understand it and separate the pertinent from that which wasn't*'. As indicated above, the researcher for this work had developed theoretical sensitivity in terms of this work due to a combination of personal professional experience of the phenomenon being investigated, and as a result of becoming immersed in the literature associated with the topic.

In addition to the development of '*theoretical sensitivity*', the researcher's concrete awareness of the process under consideration facilitated the negotiation of access to the interviewees workplaces. The professional experience of the researcher also facilitated the development of a rapport with the interviewees which in turn allowed confidence to be generated with the participants in the ensuing interview situations. As a consequence of this '*theoretical sensitivity*' the researcher and the interviewees were able to develop effective communication in which shared understanding was achieved. This shared understanding was achieved through the use of a common language which was recognised by both the interviewer and the interviewee.

6.2.3 Data analysis processes

Silverman (1993) considered the advantages and disadvantages of using computers as tools in the process of qualitative data analysis. There was concern that the use of a qualitative data analysis software package would remove the researcher from the data generated in the field. The reduction in the researcher's familiarity and immersion in the data was thought to adversely affect the emergence of concepts. However, Silverman (1993, p.155) concluded that computerised data analysis software packages could '*help increase reliability and validity of data and their contexts at all stages in the research process*'. Miller and Dingwall (1997, p.104) pointed out that computers '*could not think for themselves, could not theorise or automatically create complex data codes*', but that they did '*allow data handling to be done more accurately and thoroughly*'.

Miles and Huberman (1994, p.313) provided a general review of the differing qualitative data analysis software packages and their functions. They suggested that there was a clear answer to the problem of how to determine which of the available software packages could be considered as being the best. It was suggested that, in general, a software package should be selected following a consideration of matters such as *'the researchers expertise with computers, the particular project type, and the type of analysis required'*.

A total of twenty-four separate computer software packages were compared by Weitzman and Miles (1995, p.252) across the following categories, namely, *'coding, search and retrieval, database management, memoing, data linking, matrix building, network display, theory building, and user friendliness'*. That comparison revealed that NUD*IST4 (which stands for Non-numerical, Unstructured Data Indexing, Searching and Theorizing, 4th release) was a *'code based theory-building programme'* which was designed for the storage, coding, retrieval, analysis of text, and development of theory. In comparison to the other packages reviewed Weitzman and Miles (1995, p.256) suggested that *'NUD*IST4, ATLAS/ti and FolioVIEWS'* were the top software programmes available for *'coding orientated data analysis'*. They went on to assert that of the programmes listed it was NUD*IST4 that had *'unparalleled power in terms of code based searching'*, and it was

'an excellent package in many respects.....its tree structured index system, coding facilities, memoing capability, powerful search facilities, and system closure procedures mean that for many researchers it was the best choice'.

Contrary to fundamental beliefs in letting categories or concepts of data emerge from the collected data itself Tesch (1990, p.165) indicated that the NUD*IST4 software package called upon the researcher to begin the coding of the collected data with a predetermined *'rudimentary organising system in mind'*. Tesch indicated that this initial index could then be confirmed, expanded, altered, refined, and / or rejected as new categories emerged from the data being analysed.

This approach to category identification required by NUD*IST4 was confirmed by Weitzman and Miles (1995, p.252) who also pointed out that the hierarchical coding and index tree structure within the NUD*IST4 programme was operated on a *'top down basis'* that required high level codes to be pre-specified before analysis. Such high level codes

were then refined and altered as the analysis worked down through the data to eventually produce the '*node tips*' which were used to index the actual data. Weitzman and Miles (1995) claimed that this was an unusual feature of the software package as other data analysis programmes worked in the reverse manner in order to build their relationships in NUD*IST4 software programme could be considered as being the '*mercedes*' of the qualitative data analysis software packages that were currently available.

Strauss and Corbin (1990, p.58) indicated that analysis in grounded theory-like investigations was composed of three types of coding, namely, '*open coding, axial coding, and selective coding*'. The first step was to consider the data collected and break it down to generate initial codes that identified conceptual labels (*open coding*) which described the process being investigated. Strauss and Corbin (1990, p.59) also stressed that the rigour in this approach came from the constant comparisons of concepts and their grouping into categories that had been generated from the data, and that it was achieved by recognising that '*data collection and data analysis was a tightly interwoven process which occurred alternately in order for it to direct the selection of samples of data*'.

As indicated above it was decided to use the NUD*IST4 software package in order to facilitate the generation of conceptual labels and subsequent categories. The research design adopted had ensured that an initial set of categories, or what Tesch's (1990, p.165) termed as '*rudimentary organising systems*', had been generated for data analysis purposes within the NUD*IST4 package. Each interviewee was firstly provided with a full draft transcript of their interview in order for them to verify it for accuracy, completeness, and reliability. Upon the return of the verified draft transcript any amendments required were incorporated to form an agreed transcript which was then loaded into the programme. The data were then analysed and open codes applied to them which were initially drawn from the selection factors that had been identified and reported in chapter 5.

Samples of the subsequent index tree lists and displays showing the emerging concepts and categories of phenomena used for successive rounds of data analysis can be seen in

appendix 4

Readers Note All data analysis in NUD*IST4 has been supplied as a disc and is attached to the rear of the document. The file names are NUD*IST4 1, 2, 3, 4, and they match the successive rounds of analysis undertaken with all thirty-one interviewees.

6.2.4 Selection rationale for interviewees 1-4

Generally

The selection of appropriate participants in order to gain data related to the phenomenon being studied was seen to be of crucial importance. In quantitative studies the sample of respondents selected needed to be randomised in order to be able to generalise any results. However, in qualitative studies Patten (1987, p.51) indicated that sample selection needed to be on a more purposeful and strategic basis in order to *'select information rich participants who could be studied in depth in order that the most could be learned'*.

The first phase of the combined research design adopted for the study produced a total potential sampling frame of one hundred and sixty seven participants. Section 5.6 detailed the process by which each of the potential participants were asked to complete a participant confirmation form. This form asked each of the potential participants to provide personal biographical as well as contextual information related to their organisational setting. The form also asked each of the potential participants to score their own expertise on a scale between 1 and 3 (1 - no awareness, 2 - awareness but no experience in-use, and 3 - practical experience in-use) in relation to each of the types of building project price forecasting models found to be in use in the nation-wide survey reported in phase one of this study.

A total of ninety-five participants confirmed that it was their intention to take further part in the study when they completed and returned the form. Four of the confirmed participants

were situated in local authority type organisations which had been excluded from the statistical analysis of models in-use and so were excluded from this phase of the study.

The indicative conceptual model selection framework that was illustrated in Fig. 5.2 suspected that the organisational setting of the building project price forecaster influenced the type of price forecasting model selected for use. Therefore it was resolved to gather qualitative data from practitioners who were located in organisations of differing size and type. The database was searched for potential informants against the following criteria, namely,

(i) quantity surveying, multi-disciplinary and project management types of organisation that were either of a small (between 1 and 5 employees), medium (between six and ten employees), and large (eleven or more employees) size,

and who

(ii) had scored their own expertise as 3, (i.e. practical experience of model in-use) in the use of the traditional and at least three of the six other types of non-traditional building project price forecasting models found to be in-use'

The results of the database search have been indicated in Table 6.1. The results indicated that there were a total of fifty-five quantity surveying practices, and thirty-six non-quantity surveying practices (twenty multi-disciplinary organisations, and sixteen project management organisations) from which a purposeful sample could be selected.

Table 6.1 Organisational types of the confirmed participants in follow-on study

Organisational Type Size	Quantity Surveying Practices	Non-Quantity Surveying Practices (Multi-Disciplinary & Project Management Organisations)	Totals
Staff 1	18	3	21
Staff 2-5	22	11	33
Staff 6-10	11	9	20
Staff 11+	4	13	17
Totals	55	36	91

Table 6.2 Interviewee selection rationale¹

Organisational Types	Respondents in database	Respondents using >3 of newer models
Quantity Surveying Practices		
staff size 1	154, 449, 453, 493, 610, 631, 709, 1002, 1158, 1380, 1427, 1434, 1635, 1681, 1853, 1868 2081, 2150 (18 in total)	1635*, 1681 , 1868
staff size 2 - 5	263, 348, 369, 419, 1022, 1085, 1139, 1145, 1192, 1236, 1257, 1564, 1572, 1674, 1793, 1879, 2163, 2231, 2287, 2375, 2488, 2499 (22 in total)	263, 419 , 1139, 1145*, 2231*
staff size 6-10	109, 195, 972, 1275, 1418, 1591, 1715, 1824, 1877, 1991, 2492 (11 total)	195*, 972 , 1715*, 1991*, 2492 ,
staff size 11 +	292, 572, 1101, 1714 (4 in total)	292 , 572*, 1101*, 1714*
Multi-Disc & Project Mgmt		
staff size 1	924, 632, 1694 (3 in total)	924
staff size 2 - 5	1179, 1183, 1591, 1827, 1861, 1887, 2060, 2169, 2296, 2344, 2346 (11 in total)	1183*, 2346
staff size 6 - 10	380, 592, 919, 1081, 1161, 1499, 1701, 1723, 2390, (9 in total)	592*, 1499, 1701 , 1723*
staff size 11+	230, 285, 635, 666, 698, 1123, 1177, 1205, 1215, 1314, 1458, 1504, 2177, (13 in total)	230 , 285*, 635 , 698*, 1177 , 1205*, 1314*, 1458*, 1504

¹The key respondents who comprised interviewees 1 - 14 have been shown in bold (1681).
Interviewees 15 - 31 have been indicated by an asterisk (1635*)

Interviewees 1 - 4

The analysis of the quantitative data generated by the nation-wide survey of models in-use indicated that the most popular type of quantity surveying organisation involved in the provision of building project price advice in England was the small sized quantity surveying practice. The analysis of the survey data also indicated that the small sized quantity surveying practice was the type and size of organisation that was least likely to make as much use of the full range of types of building project price forecasting models as compared to other organisations of larger size and different type. It was decided to start the fieldwork in a small sized quantity surveying practice that used at least three of the six types of newer non-traditional types of building project price forecasting models that were found to be in-use.

Accordingly, the database of confirmed participants was searched in order to identify organisations that classified themselves as being quantity surveying practices which employed either one, or between two and five members of staff. The results of the database search have been illustrated in Table 6.2. A total of eighteen of the confirmed participants had described themselves as being quantity surveying practices in which only one member of staff was involved in the formulation of building project price advice. Of those eighteen respondents only respondents 1635, 1681, and 1868, had practical experience in the use of at least three of the six newer computerised building project price forecasting models. Each were contacted and access was negotiated with respondent 1681 who became interviewee 1.

A total of nine of the confirmed participants had described themselves as being either multi-disciplinary or project management types of organisations which employed between six and ten members of staff in the formulation of building project price advice. Of those nine respondents it was found that respondents 592, 1499, 1701, and 1723 had practical experience in the use of at least three of the six newer computerised building project price forecasting models. Access was negotiated with respondent 1499 who became interviewee

Of the twenty-two organisations that styled themselves as being quantity surveying practices in which between two and five members of staff were involved in the building project price forecasting process only respondents 263, 419, 1139, 1145, and 2231, had practical experience in the use of at least three of the six newer computerised building project price forecasting models that were found to be in-use. Access was finally agreed with respondent 419 who became interviewee 3.

Of the thirteen organisations that styled themselves as being either multi-disciplinary or project management type organisations in which over eleven members of staff were involved in the building project price forecasting process only respondents 230, 285, 635, 698, 1177, 1205, 1314, 1458, and 1504, had practical experience in the use of at least three of the six newer computerised building project price forecasting models. Access was agreed with respondent 635 who became interviewee 4.

Negotiations regarding access were on a direct basis and it was generally found that the potential interviewees were the organisation's 'gatekeepers' who were receptive to the suggestion of arranging meetings in their own workplaces once the background, purpose, and proposed length of such meetings had been established. Key factors in the establishment of such meetings were,

- (i) the ability to indicate that the study was for educational purposes and that it was supported by the Education Trust of the RICS, and
- (ii) the assurance that the proposed meetings would not be more than one hour in length.

The first round of meetings (interviews 1-4) adopted an unstructured, in-depth, non-directive approach. It was considered important that the researcher and the researched established a good rapport and that the interview was conducted in a non-threatening and non-hierarchical manner. The taped conversations of interviews 1-4 lasted on average thirty-five minutes. To facilitate this co-operative atmosphere the researcher ensured that he dressed in a similar manner to the informants and that the language used in the interview did not convey any sense of the researcher being more informed than the informant on the central issues of the study.

The concepts that were illustrated in Fig 5.2 and the criteria that were listed in Table 5.4 were used as the basis for guiding the start of the conversations that formed the basis of the interviews. This approach ensured that there was a means of comparing the theoretically based data reported in chapter 5 with the newly emerged data that was grounded in the experience of the interviewees.

The initial round of interviews (1-4) were conducted in the early summer of 1997.

Miller and Dingwall (1994, p.31) concluded their discussion on the differing perspectives of data collection and analysis within qualitative research design with a piece of practical advice which seemed to be particularly apt to quote at this point of the study. Their advice was,

'if you were going to tell a story then you had to be less epistemologically squeamish about it and get on and tell it'.

The next stage in the exploration of the factors affecting the selection of building project price forecasting models called for the data collected from the first set of practitioners in the field to be inductively interpreted into abstract sets of explanatory inter-related concepts. The first step in that process required an evaluation of the initial indicator proposition that had been developed as a result of the work previously carried out and reported in phase one of the study.

6.3 Indicative conceptual environments and emergent data analysis

6.3.1 Generally

Fig. 5.2 illustrated that factors related to organisational setting as well as individual model selection criteria that were suspected as affecting the selection of building project price forecasting models for use.

The individual selection criteria were listed in Table 5.4 prior to subsequent grouping into five separate conceptual environments, namely (a) the forecast user's environment, (b) the forecast preparer's environment, (c) the forecasting organisation's environment (d) the forecast model's environment, and (e) factors related to the proposed project's characteristics.

The results of the statistical analysis of the quantitative data collected via the nation-wide survey of models in-use had indicated that factors related to the organisational setting of the forecaster affected the building project price forecasting selection process. Such factors were found to relate to issues of organisational size, type, and ratio of staff to personal computers. A further organisational factor that was originally thought to be relevant was the geographical location of the organisation. However, following statistical data analysis it was not found to be a factor that influenced the incidence of particular models in-use. This survey work together with the theoretical sensitivity of the researcher enabled an initial indicative proposition, as defined by Strauss and Corbin (1990), to be formed, namely,

'The selection of particular building project price forecasting models depended upon the interrelationship of (a) the forecast user's needs, (b) the forecast preparer's skills, (c) the forecasting organisations resources, (d) the forecast model's attributes, and (e) factors related to the proposed projects characteristics together with the contextual setting of the forecaster in terms of organisation size, type, and ratio of staff to computers'.

Strauss and Corbin (1990) stressed that a well grounded indicative proposition would encompass the potential conceptual explanation of the process under investigation and provide a focused starting point from which investigations with practitioners in the field could be structured.

6.3.2 Comparison of theoretical and emergent data

The transcribed data from interviews 1 - 4 were entered into the NUD*IST4 software package as a '*project*' in their own right for analysis. The analysis package required an initial set of codings to be entered within an index system set up for the '*project*'. It was decided that the codings entered into the initial analysis index system would be the twenty-eight model selection criteria that were listed in Table 5.4.

Coding labels related to the selection criteria located within each of the conceptual environments (a) - (e) - identified above were then entered as a set of non-hierarchical factors into the initial analysis framework as '*nodes*'. This framework enabled the NUD*IST4 analysis package to group together data with similar codes. This grouping of data would in itself facilitate an exploration of cross case comparisons and subsequent selection of further informants. The initial codings, their associated '*nodes*', and the memos generated as a result of the analysis can be viewed in the data analysis disc supplied. Table 6.3 presents an overall quantitative indication of the data collected from interviews 1 - 4 and analysed against the framework set out above.

Table 6.3 indicates that of the twenty-eight criteria that were initially included within the initial model selection indicator framework a total of nine criteria had no data allocated to them. The criteria that were seen as being less significant were,

the forecasters understanding of the model, the ease of model output interpretation, the flexibility of the model in-use, the cost of using the model, the design consultants for the project, the quality levels for the project, the availability of computers, the anticipated shape of the project, and the geographical location of the project.

The analysed data from interviewees 1-4 indicated that lack of model understanding was not a criteria that affected their selection of particular types of models. This was not an unexpected result. Each of the interviewees who had agreed to participate in this study had already indicated on the original questionnaire form, and on the participant confirmation form, that they had practical experience of selecting both traditional and non-traditional types of building project price forecasting models for use. Evidence collected from the nation-wide survey had indicated that lack of understanding was a negative factor that was affecting the selection of non-traditional types of building project price forecasting models. However, Fig. 3.2 indicated that although lack of model understanding was a significant factor affecting the non-use of

non-traditional models it was not a dominant issue. Given the purpose of the inquiry and the nature of its participant selection strategy it would be surprising to find that lack of model understanding was an issue that emerged from data grounded in practitioner experience.

Table 6.3 **Comparative analysis of theoretical and emerging selection criteria (interviewees 1 - 4)**

<i>Nr</i>	<i>Potential Model Selection Criteria (Identified from literature)</i>	<i>Avg Score (1-5)</i>	<i>Model Envmt- Prelim</i>	<i>NUD* IST4 Code</i>	<i>Nr of Text Units</i>
1	Amount of project data available	4.32	A,B,C	11,21,31	190
2	Data needed for model	4.17	B,D	2.2,4.1	46
3	Forecasters understanding of the model	4.15	B	2.3	-
4	Time available for forecast preparation	4.11	A,D	1.2,4.2	126
5	Project type	4.04	A,B	1.3,2.4	44
6	Accuracy of model output	3.97	B,D	2.5,4.3	112
7	Forecasters experience of model in-use	3.87	B	2.6	36
8	Amount of judgement requ'd for model use	3.79	B	2.7	21
9	Ease of interpreting model output	3.77	B	2.8	-
10	Amount of risk in project decisions	3.77	B	2.9	27
11	Ease of model application	3.63	B,D	2.11,4.4	49
12	Feedback from previous forecasts	3.58	C	3.2	6
13	Nature or purpose of the forecast	3.57	A	1.4	76
14	Speed of the model in use	3.56	D	4.3	12
15	Human resources required to operate model	3.38	C	3.3	21
16	Site characteristics of the project	3.36	-	5.4	-
17	Level of awareness of new models	3.29	C	3.4	47
18	Flexibility of model in use	3.28	D	4.6	-
19	Project size	3.25	-	5.2	45
20	Nature of the client	3.23	A	1.5	22
21	Market conditions	3.22	-	5.3	4
22	Cost of using model	3.19	D	4.7	-
23	Design consultants for the project	3.05	-	5.6	-
24	Quality levels required in the project	3.05	-	5.5	-
25	Availa'ty of computers for use with model	3.04	C	3.5	-
26	Relationships with forecaster and manager	2.67	B,C	2.11,3.6	71
27	Anticipated shape of the project	2.65	-	5.7	-
28	Geographical location of the project	2.55	-	5.8	-

Four of the other criteria that were also indicated as being insignificant to practitioners had been included within conceptual environment (e) project characteristics. This

result, together with the generally lower quantitative scores that were previously awarded to the same criteria by the building project price forecasters in the field indicated that the separate sub-category coding status awarded to each of the criteria within this environment and conceptual environment (e) itself should be reviewed.

Table 6.3 also revealed that five of the selection criteria included within the original list of twenty-eight potential selection criteria attracted over seventy per cent of the text analysed from this initial round of data analysis. The criteria concerned were,

(i) amount of project data available, (ii) time available for forecast preparation, (iii) accuracy of the required output, (iv) nature and purpose of the forecast, and (v) the relationship between forecaster and forecast manager

Three of the five criteria listed above were also scored within the top six criteria by the respondents to the quantitative study that was reported in chapter 5. The more significant of the criteria concerned were,

(i) amount of project data available, (ii) the time available for forecast preparation, and (iii) the accuracy of the required output.

This initial comparison of data on the criteria thought to affect the selection of building project price forecasting models revealed a lack of consensus between the subject specific literature and practice in terms of what each believed were significant factors affecting model selection. The results of this initial comparison raised issues related to the relevance of the criteria located within conceptual environment (e), namely, the proposed projects characteristics as model selection criteria. Their separate identification and the continued inclusion of conceptual environment (e) itself, needed to be reviewed following the more qualitative analysis of the data collected from interviewees 1-4.

This type of quantitative analysis of the data so far collected did not provide any further information on how or why or in what circumstances such factors were significant for the construction professionals who operated in the field. It was resolved to undertake a more in-depth inductive analysis of the data so far collected in order to more fully explore the criteria so far identified. Such an analysis would enable more defined grounded conceptual environments to emerge which would then influence the selection of interviewees for the next rounds of data collection.

It was also recognised that it would not be possible to explore the impact of factors related to differing organisational size, type, and access to computers within the data collected in this first round of interviews. The analysis that was carried out was designed to contrast the emergent data with the initial model selection concepts (a) - (e) that had been intuitively developed. Data assigned within each of the main conceptual environments was now considered in turn.

6.3.3 Forecast user's environment - category (a)

Fig. 6.1 illustrates the coding labels for each of the sub-categories listed within the initial conceptual data-analysis-framework that were related to category (a) - the forecast user's environment. The reference number following each coding label is the ranking achieved by the selection criteria as a result of the quantitative data collection exercise reported in chapter 5 - see Table 5.4

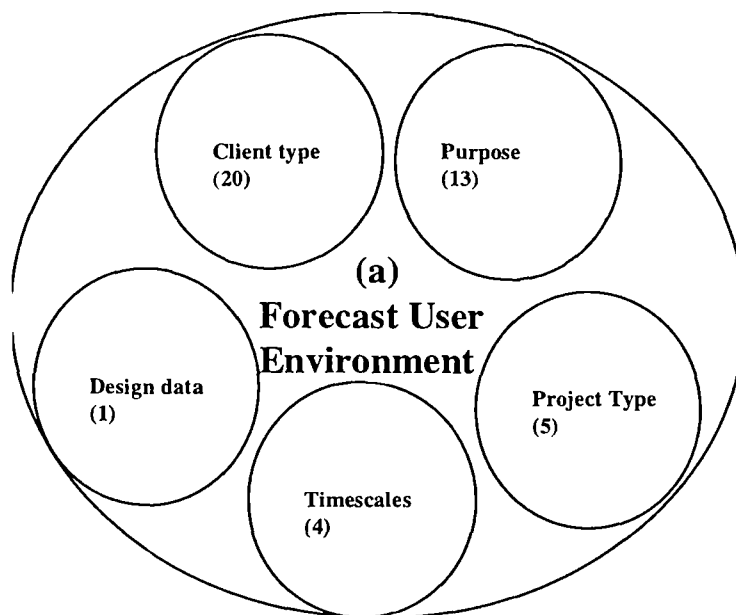


Fig. 6.1 Conceptual environment - (a) Forecast user

Design data

This coding label related to the amount and availability of project data that was available at the time that a building project price forecaster was required to select a type of model for use.

The significance of this criterion as an emerging sub-category was indicated by interviewees 1 and 2 when they commented, '*... the information provided often determines the way in which a rough cost or price forecast is produced*' (text unit (tu) 9-10¹) and '*the choice of technique (model) is usually influenced by the level and type of information available*' (tu 178-179). The use of the word '*often*' implied that there were other issues that affected the choice of model. Similarly the use of the word '*provided*' in the comment by interviewee 1 placed the responsibility for the availability of project data with 'others' i.e. the forecaster's client.

The 'level' and 'type' of available project data were issues that emerged from the data indicated above. The use of the words 'level and type' in the context of project information availability implied that there was the potential for variation in the amount of detail made available at building project price forecasting stage, and that this phenomenon impacted upon the actual model selected for use. Comments by interviewees 2 and 3 indicated that there were differing levels and types of information provided, namely,

'... sometimes the information provided is in a written format, perhaps as a preliminary specification ... in such cases I would provide cost advice that was framed within an appropriate range of figures often based upon my judgement' (tu 187-189),

and

'...in a normal situation sketch scheme drawings would be produced from which approximate quantities could be produced, although there would never be a full set of drawings available for us to consider' (tu 408-411)

Interviewees 1 and 2 indicated that a movement in the level of project information also caused a movement in the price forecasting model selected for use when they commented, '*...if there were no drawings available then I would be more prepared to use my judgement*' (tu 78 -70) and '*... as more information becomes available then I*

¹Text unit (tu) refers to the line reference within the analysis print out from the NUD*IST4 software package.

would move from providing cost advice that was based on costs/m² to providing advice that was based on an elemental analysis' (tu 180-182)

However, interviewee 4 did not support the general proposition that the model selected for use changed as the level of detail changed. For instance, interviewee 4 responded to a direct question on this matter by saying,

'No, a change in the level of project information would only cause a change in the level of detail within the cost model being used' and 'a change in the level of detail available would cause the forecast to be updated using the same technique rather than change to another technique' (tu 660-662).

This comment was thought to reflect the significance of computerised cost models within interviewee 4's organisational setting and this was an issue that was noted as being necessary to address in terms of the selection of future participants

The potential for differing types of project information was brought out in a comment from interviewee 3 when he said,

'...typically an experienced client would make a phone call asking for some cost advice about a proposed project..... there would be no drawn or written information... the work would be described in terms of say size, major items of work required the figure required would be a gut feeling based on my judgement and experience.....this figure often becomes the budget for the entire project' (tu 338-343)

This comment drew out a third type of project information, namely verbal information and provided an indication of how some building price forecasters would respond. The comment provided evidence of a link between the availability of project data, and related issues, such as differing types of client, the amount of time available to produce the forecast, and the purpose or need for the forecasted figure. The exploration of such links needed to be investigated once the sub-category related to the availability of project data had more fully emerged.

The analysis indicated above provided sufficient evidence from within the data collected from interviewees 1 - 4 to indicate that not all data available at the time of building project price forecasting model selection was design data. It was decided to re-label this sub-category as '**project data**' within the category (a) the forecast user's conceptual environment in the developing grounded data-analysis-framework.

Timescale

This coding label related to the amount of response time available to the forecaster involved in the selection of a type building project price forecasting model.

Confirmation of this criteria as an emerging model selection sub-category was indicated by interviewee 2 who commented, '*...the time available for the early cost advice to be produced would have an effect on the type of cost model used*'. (tu 279-280). Interviewee 4, in response to a direct question that sought confirmation of the link between the time available and its effects on the determination of the actual technique selected for use, responded by saying, '*yes ... the time available dictates the technique used in so far as in some cases cost forecasts could be provided on a more rough and ready basis using costs/m² instead of other models*' (tu 390-392)

The above comment indicated that differing amounts of time available for the production of the forecast resulted in differing types of models being used. The existence of this relationship was confirmed by further comments from interviewee 4 when he said, '*in some circumstances the pressures caused by having only limited time available for a response would preclude the use of more sophisticated software*' (tu 618-620). Interviewee 3 supported the existence of this relationship and indicated the consequences of having only limited response time on the selection of forecasting models for use when he said, '*...if time allows the organisations own cost model could be used to generate a forecast*' (tu 370-371).

This comment suggested that in order to use the organisations in-house computerised cost models there had to be additional resources of time available. But 'how much time' needed to be available in order for which type of model to be used? Interviewee 4 provided an early indication of timescales when he said, '*... therefore we have an ability to produce a cost for a client who needs that information tomorrow by using the organisations cost database and computerised cost models*' (tu 593-595). This comment suggested that the client was responsible for setting the response time from the building project price forecaster, and that the type of model selected for use in

formulating that response depended on organisational factors such as, the existence of a cost database and the availability of computerised cost models.

The comment also indicated that when a response was required within hours then some forecasters believed that it could not be achieved by using the organisations in-house computerised cost models. This evidence is at odds with the generally perceived advantages of using computerised cost models, namely, speed in use.

The potential interlinking of selection sub-categories related to time availability and client demand was also indicated in comments made by interviewee 3 when he said,

'...the information would be requested by a telephone call and our response would be required straight away as the client would be considering the potential project in terms of its potential sales and profit margins' (tu 343-345)

Interviewee 3 went on to suggest that the need for a fast response affected the selection of certain types of model for use when he said, *'... depending on the speed within which the client required the information then we would use the computerised estimating system or use traditional methods'* (tu 378-380). This comment provided some dimensional information on the impact of time availability on model selection and suggested that traditional models were used when responses were required in short timescales and computerised cost models were used in situations in which responses were required over longer timescales.

A relationship between model selection sub-categories related to time availability and the availability of project data, typically drawn project data was evidenced in comments made by interviewee 1 who clearly stated, *'... the method used to determine a price forecast depends on the level of information available and the time available to produce a response'* (tu 108-110). Interviewee 4 confirmed this relationship and indicated some consequences of it on the choice of traditional forecasting models when he answered a direct question which asked him to identify the circumstances which would determine the techniques used to produce an early cost forecast, by saying,

'Yes ... in a situation when there has been some drawn information generated the time available will affect your approach... we would move from producing a forecast on a cost/m² basis in a situation with little time or no information available to a situation of producing elemental costs related to some outline preliminary sketch scheme drawings' (tu 645-653)

Interviewee 1 provided some further dimensions on the type of project data that needed to be available in order to cause a change in the selection of certain traditional cost models when he commented '*...I would wait for plans and elevations to be produced from which I could if time allowed, produce approximate quantities*' (tu 52-54).

The need to respond to a client demand within a short time period together with the lack of drawn information was perceived as adding a further link to another of the previously identified model selection criteria, namely 'risk perception'. Interviewee 2 provided an indication of the existence of this link when he said, '*... the risk involved in producing a forecast is added to by a lack of time available ... the amount of risk involved in the project is reflected in the time available for the early cost advice to be produced*' (tu 277 -279). The impact of this linkage on the identified selection phenomena needed to be further explored in the analysis of data that was initially coded within the forecast preparer's environment.

The analysis indicated above provided sufficient evidence to identify the conceptual label of '**timescale**' as an emerging sub-category in the developing grounded data-analysis-framework. Evidence was presented of links to other potential sub-categories such as client demand, project data, and risk perception which needed to be further explored

Project type

This coding label was related to the consequences of differing types of projects on the forecaster involved in the selection of building project price forecasting models for use. In particular this coding label related to one-off or repeat projects as examples of the types of projects that could impact upon the model selection process.

The only data that directly addressed the effect of project type on the selection of forecasting models were data gathered from interviewees 1 and 2. Interviewee 1 indicated that a change in the size or scope of the proposed project would not cause a change in model selection when he said, '*the projects may vary in size and scope from a simple boat house to a high quality large and complex residential development.*

The techniques I would use would be the same, i.e costs per m², judgement, and approximate quantities if the level of information permits' (tu 12 -17).

However, the type of project being referred to by interviewee 1 reflected the limited range of project types that he was involved with and so the comments made did not provide any strong negative evidence. The use of the words '*if the level of information permits*' provided evidence of a potential link to another selection framework sub-category, namely, the amount of project data available.

Interviewee 2 provided some additional evidence that the type of project could have an effect on the actual model chosen for use when he said, '*if a project is a one-off in nature then it may be necessary to use approximate quantities*' (tu 372-373). The data analysed above provided some evidence of the existence '**project type**' as an emerging sub-category in the developing grounded data-analysis-framework. However, the evidence so far collected and analysed was not sufficient to come to a view on the impact of this sub-category on the model selection process. It was resolved to review the status of this sub-category following the analysis of further data.

Purpose

This coding label related to the nature or purpose of the forecast and its impact on the forecaster involved in the selection of building project price forecasting models for use.

The insignificance of this criteria as an emerging sub-category was indicated by the fact that all the data initially assigned to this coding label was incorrectly coded. The data should more correctly have been coded at the emergent sub-category of client type.

Client type

This coding label related to effects that differing types of clients had on the actual process by which practitioners selected building project price forecasting models or tools for use.

Interviewee 1 commented, '*you would have to look at the client and in some cases it may not be appropriate to use cost/m²*' (tu 57-62). This comment indicated that other

models would be used for other types of clients. This contrasted starkly with interviewee 4 who said *'however as far as I am concerned I would say that the client type would not influence the choice of technique to use in any way at all'* (tu 697 - 705). It may well be that the differing organisational sizes and types as well as the differing personal perspectives have influenced the polarity of these comments but it was not possible to say so reliably until further data had been collected from the field.

Interviewee 1 indicated that different types of client demand had an impact on the selection of building project price forecasting models when he said, *'I have used life cycle cost models for services type of installations but only when I have been specifically requested to do so by my client'* (tu 154-156). Differences between clients was also recognised by interviewee 2 who, in response to a direct question on the consequences of client type on model selection replied by saying,

'generally no except for certain government clients such as the Ministry of Defence or the Home office who require full risk analysis ... other clients ask us to become involved with life cycle cost analysis and value engineering ... these would be seen as additional services ... and so in these circumstances you could say that the client influenced the choice of forecasting model used'
(tu 260 - 267)

Such comments confirmed that client model demand could be considered as an emerging property of the emerging sub-category of client type. In addition interviewee 2 commented that he thought that there were different client types, namely the experienced and the inexperienced, and that this was a factor that affected the way in which forecast models were selected for use. The identification of further emerging properties within the emerging sub-category of client type was evidenced when interviewee 2 commented that,

'...there are experienced clients that we have worked with in the past. This allows us to develop a cost database... such clients would require us to become involved with a risk analysis type of model ... such skills are based in our London office' (tu 196-201).

This comment revealed other organisational issues that affected the selection of particular forecasting models, namely, the existence or not of an internal organisational cost database and the capability of large nation-wide organisations to use their structure to create additional resources and expertise when required.

Differences between experienced and inexperienced clients was also evidenced by interviewee 2 who said,

'typically an experienced client would make a phone call asking about cost advice for a proposed new scheme... a figure would be provided that was a gut feeling based on my judgement ... an inexperienced client may contact us and not be aware of what is required ... we would immediately recognise that we were entering a risky situation ... we would seek more information before making our forecast' (tu 388-486)

The analysis indicated above provided sufficient evidence to justify the merging of the sub-categories related to forecast purpose and client type. The new merged sub-category was re-labelled **client type** within the developing grounded data-analysis-framework. The existence of emerging properties such as **sophistication** and **demand** related to this emerging sub-category needed to be confirmed following the exploration of further data.

Summary

The data analysed within this environment has confirmed its relevance to the building project price forecasting model selection process. On reflection, the evidence presented indicated that this environment should be re-labelled in order to focus it as a model selection category more related to the forecaster involved in the actual model selection process rather than the receiver of the transmitted forecast. Accordingly it was decided to re-label this environment as category **(a) project awareness**.

The data analysed did allow the following sub-categories to emerge, namely, **(i) project data**, **(ii) timescale**, **(iii) project type**, and **(iv) client type**. These sub-categories were incorporated into the emerging grounded data-analysis-framework which was used to analyse further data. The continued inclusion of sub-category **(iii) project type**, within this model selection category needed to be reviewed following the next round of data analysis. The data analysis also indicated some evidence to suggest links between the following sub-categories, namely, client type, timescale, and project data.

Conflicting evidence was presented within this initial round of data analysis about the impact of differing levels of design data and the impact of differing types of project on

the model selection process. This conflict called for a further round of data analysis. In particular further evidence needed to be collected from forecasters located in similar contextual settings as interviewee 4 who was suspected as being non-typical of forecasters located in large project management type consultancies. Similarly further data needed to gathered in order to explore the dimensions of emerging links between the model selection sub-categories. Analysis of further data collected would also reveal the identity of any grounded properties that were relevant to the emerging model selection sub-categories within the re-labelled model selection category of (a) project awareness.

6.3.4 Forecast preparer's environment - category (b)

Fig. 6.2 illustrates the coding labels for each of the sub-categories listed within the initial conceptual data-analysis-framework that were related to category (b) the forecast preparer's environment.

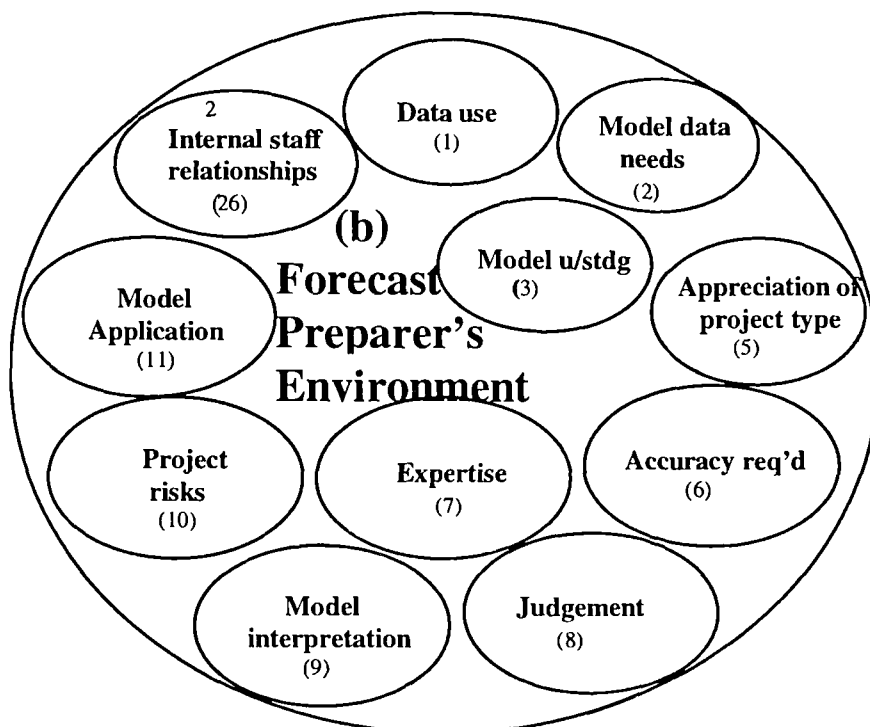


Fig. 6.2 Conceptual environment - (b) Forecast preparer

The analysed data collected from interviews 1 - 4 indicated that there were no data assigned to the following coding labels, namely data use, model understanding, and model interpretation. Evidence related to these potential sub-categories either was not present within the data or had been assigned to other coding labels. It was decided to consider the collapse or merging of the sub-categories indicated above at the next stage of the conceptual data-analysis framework development

Model data

This coding label related to the forecasters perception of the data needs of the forecasting model selected for use and its impact as a factor on the building project price forecasting model selection process.

The data assigned to this sub-category indicated that it had been mis-coded. The comments made by interviewee 2 and 3 revealed a reluctance to change from the traditional type of forecasting models that they had been accustomed to using. For instance, interviewee 2 commented

'I have not used the newer computer based and statistical cost models ... I see no need to use them as the traditional models I use produce results that have been consistently reliable and accurate ... why should I use these newer techniques when the ones that I am using are doing OK' (tu 115-120)

This analysis did not reveal any support for this sub-category and so it was merged into another emergent sub-category, namely, data for the model, which was more related to the model itself. However, a further emerging conceptual label was identified that was related to intransigence or inertia on the part of the forecast preparer. This emerging sub-category was labelled as '**forecaster style**' in order to facilitate its inclusion in the next stage of the data-analysis-framework development. It was resolved to review the status of this emerging sub-category following the analysis of further data.

Project type

This coding label related to the forecasters appreciation of the project type and its impact on the building project price forecasting model selection process.

The data analysed at this sub-category indicated that it had been mis-coded. The comments made by interviewee 1 and 2 were more related to the type of work that the forecast preparer was involved with than the forecast preparer's appreciation of the project type. For instance, interviewee 1 commented, '*... perhaps the type of work that I am involved with does not encourage me to consider changing away from the tried and trusted methods that I have used so far*' (tu 121-123)

This analysis did not reveal any support for this sub-category and so it and its data were merged into the already emerging sub-category that was labelled project type in model selection category **(a) project awareness**. The issue of work experience that did emerge was judged to be more relevant to the sub-category that was labelled expertise.

Accuracy

This coding label related to the forecasters assessment of the accuracy of the forecast required by the client and its impact on the building project price forecasting model selection process.

The relevance and significance of **accuracy** as an emerging sub-category was indicated by comments from interviewee 3 who said, '*accuracy was the main factor that determines the choice between techniques, it would be expected that the figures produced would be accurate to about 5%*' (tu 501-502), and again when interviewee 4 commented '*accuracy is always important when choosing between techniques, that really goes without saying*' (tu 573-575). Such comments confirmed the reasons why this criteria was highly scored for importance in the quantitative study that was reported in chapter 5.

The initial classification of this model selection sub-category within (b) the forecast preparer's environment indicated that the impact of this model selection criteria was thought to affect the forecasters assessment of the accuracy required by the client. Comments such as '*... the accuracy of the cost forecast can be very important to certain clients*' (tu 72-73) by interviewee 1 confirmed that this initial classification was appropriate. The comment from interviewee 1 also indicated that different types of

clients required differing levels of accuracy from their building project price forecasters. This demonstrated a potential linkage between the sub-categories of accuracy, and client type.

Interviewee 1 provided further evidence of the link between the accuracy of the required forecast and the type of client when he commented '*in terms of achieving the best value for the money available, the client is very concerned that the cost advice provided is as accurate as it can be*' (tu 66-68). Similar comments by interviewee 3 started to signal the strength of the emerging relationship between client type and the accuracy of the forecast required when he commented, '*if we were not accurate then we would lose the opportunity to work for that client in the future*' (tu 501-503).

An indication of the level of accuracy required by certain clients and the importance that building project price forecasters themselves placed on accuracy was provided by interviewee 3 who said '*we are usually between 1-3% of tender costs, ... if we were not that accurate then our necks would be on the line*' (tu 504-506).

A further link between the emerging sub-category of accuracy and the previously identified sub-category of project data was provided by interviewee 4 who commented '*the level of accuracy that was formerly possible can not now be achieved without a great deal more drawn and written information being available*' (tu 583-584). Previous analyses had indicated that the timescale was an important factor that influenced the availability of project data.

However, stronger evidence of a relationship between the levels of accuracy required and the size of the proposed project was provided by interviewee 1 who said, '*on a large scheme ... say for instance the £1 million house then the client would not be so concerned with accuracy as he is more concerned that the right scheme is developed in terms of his particular quality needs*' (tu 69-71). Of course the assessment of project size was a relative judgement and in terms of other types of quantity surveying organisations it may well be that an anticipated project value of one million pounds would not be perceived as being a project that was that large in size.

Interviewee 1 went on to provide evidence of a relationship between anticipated project accuracy levels and the actual model selected for use when he said, *'if it was a larger scheme then I would prepare approximate quantities from the available drawn information that would give me more of a basis upon which to determine a more accurate forecast'* (tu 49-54). Interviewee 1 was a sole practitioner working from an office within his own dwelling, and as such the resources available, in terms of internal organisational cost databases were very limited. Interviewee 1 went on to comment *'the functional models and other models listed do not achieve the required levels of accuracy and so I am not happy to use them'* (tu 98-100).

This comment revealed the emphasis that interviewee 1 placed on the traditional types of building project price forecasting models and this can be contrasted with the comment on model selection by interviewee 4 who said, *'we do have the ability to produce a more accurate figure due to the computer techniques that we have available'* (tu 740-741).

Such a contrast in the comments made by interviewee 1 and 4 provided an illustration of the perceived differences in approach and access to operational resources between building project price forecasters located in small quantity surveying practices and larger sized multi-disciplinary or project management organisations. Such a potential linkage needed to be further explored following the collection and analysis of more data from practitioners in the field.

The tone and context of the comments made about the perceived levels of required accuracy indicated that the interviewees considered the production of an accurate forecast to be a risky activity. Interviewee 4 summarised the position when he said, *'if we are talking about the risk that our forecast is not accurate then once again we can be liable for criticism if there is a gap between our first estimate and the subsequent tendered figure'* (tu 735-737). Further exploration into the extent of the relationship between perceived project risks and accuracy levels required in terms of their consequences on the building project price forecasting model selection process. The comment from interviewee 4 also identified a further emerging conceptual label from within the data analysed. The use of the phrase *'first estimate and subsequent tender*

figure' indicated that more than one forecast could be required. Accordingly the emerging conceptual coding label of '**timing**' was established in order to be incorporated into the developing grounded data-analysis-framework.

Expertise

This coding label related to the forecasters experience and expertise with the differing types of forecasting models and its impact on the process of building project price forecasting model selection.

The relevance and significance of this emerging sub-category was indicated by comments such as '*I am aware of these newer models, but at the end of the day the models are only as good as the information that is entered into them*' (tu 131-132) from interviewee 1. However the majority of the text analysed within this sub-category indicated that in terms of experience it often had a negative impact on the selection and use of particular types of model. For instance interviewee 1 also commented '*... I have a general lack of confidence in such computerised models*' (tu 131-135) which indicated a reluctance to move away from using the traditional types of cost model.

Similarly, interviewee 2 commented that his lack of experience had a negative effect on the selection and use of statistical models when he said '*...well I suppose that factors such as lack of personal and organisational confidence in the output of such models would be issues that would limit my choice, but other factors such as lack of appropriate data would also have an effect*' (tu 233-236). This comment reinforced the comment made by interviewee 1 about '*lack of confidence*' in terms of the selection of certain types of model. The comments from interviewee 2 indicated that the context in which that lack of confidence was allowed to develop was caused by a feeling of being constrained due to either a lack of personal or a lack of organisational opportunity.

The following comments made by interviewee 4 indicated a further reason why certain models were not selected for use, namely, '*we have used the ELSIE expert system and found it to be unsatisfactory due to the modelling of costs within it*' (tu 629-631). These comments indicated that this interviewee was not selecting the ELSIE expert system

due to experience or feedback from the model in use which had indicated that it had been producing unsatisfactory results.

The limited data analysed in relation to this sub-category has provided some evidence of how 'lack of experience' and 'bad experiences' and either direct or indirect 'feedback' could impact on the process of model selection. Further data needed to be collected and analysed before this grounded sub-category provisionally labelled as '**experience**' could be reliably included within a grounded data-analysis-framework.

Judgement

This coding label related to the forecasters assessment of the amount of judgement required to use the model and its impact on the process of building project price forecasting model selection.

The relevance and significance of this emerging sub-category was indicated by interviewee 3 who commented that, in relation to using computerised cost models, '*... a more experienced surveyor who would fine tune the end product using their professional judgement. It is absolutely essential that the surveyor applies their professional judgement*' (tu 431-435). The importance of applying professional judgement was again highlighted in comments made by interviewee 4 when he said '*...the ability to exercise judgement is important to a practitioner as there is a suspicion that the model itself does not fully take into account all the project circumstances*' (tu 632-634)

The data analysed above have confirmed that the practitioners use of judgement was seen as being significant in terms of their selection of particular models for use. Although the data analysed indicated that **judgement** was an emerging sub-category within the developing data-analysis-framework it has not yet been able to provide any illumination on 'how' or 'why' the forecasters use of judgement is important. The analysis of further data would enable the properties related to this sub-category to become more clear.

Project risk

This coding label related to the forecasters perceptions of project risks and its impact on the process of building project price forecasting model selection.

The relevance and significance of **project risk** as an emerging sub-category was indicated by comments from interviewee 1 who said, *'I do not normally get involved with providing any pre-design cost information due to the risks involved in providing cost information that could subsequently turn out to be wrong'* (tu 29-30). Such comments indicated that this building price forecaster perceived that the provision of unreliable cost forecasts would affect the future commercial opportunities of his organisation. There was some evidence of a link between perceived levels of risk and the already emergent sub-category of project data. In addition there was evidence of a link between perceived risk levels increasing as the size of the proposed project increased. This link was evidenced in further comments from interviewee 1 when he said, *'on large schemes the risks caused by providing a cost forecast that proved to be in error would be greater and so I would wait for plans and elevations to be produced'* (tu 49-54). This comment indicated a further link to the emergent sub-category of timescale.

Interviewee 1 was a sole practitioner and the above comments were found to be in sharp contrast to comments made by interviewee 4, who was a price forecaster located within a large nationwide organisation. When asked a direct question related to the perceptions of commercial risks to his own organisation of providing forecasts and whether such perceptions altered his choice of techniques to use, interviewee 4 replied by saying, *'No, I don't think so'* (tu 730- 732). This difference in view between interviewee 1 and interviewee 4 may be related to the respective sizes and structure of their organisations. Clearly this matter needed to be explored by analysing further data.

Model application

This coding label related to the ease with which forecasters were able to apply the selected model in-use and its impact on the process of building project price forecasting model selection.

The relevance and significance of model application emerging sub-category was indicated by comments from interviewee 1 who said, *'the newer computer based models and the statistical models that are available I have not used and see no need to use them as the traditional models I use produce results that are and have been consistently reliable and accurate'*, (tu 116-118). The comments from interviewee 1 did not provide any direct evidence of the reluctance to change models as a result of their lack of ease in application. Rather the context of the comments indicated that the ease of model application as a conceptual coding label may be inter-linked within the already emerged sub-category of experience.

The lack of any other analysed data associated with this potential sub-category caused its continued existence as a separately identified sub-category within the emerging grounded data-analysis-framework being to be reviewed.

Internal staff relations

This coding label related to the forecasters internal organisational staff relationships and its impact on the process of building project price forecasting model selection.

The confirmation of this emerging sub-category amongst the data analysed was indicated by comments from interviewee 3 who said *'..yes, pretty much so'* (text units 458 460) in response to a direct question on whether internal relationships had any consequences on forecasting models selected for use. Interviewee 2 provided an indication of how internal relationships could affect the forecasting model selection process when he commented,

'If a more junior member of staff was able to convince me of the worth and value of using a newer computer based cost model then I would like to think that I would be adaptable enough to consider the output and apply my own expertise and judgement to the figures' (tu 243 245)

These comments indicated that it could be that the more junior staff within large organisations were more familiar with the newer cost modelling techniques than their more senior colleagues. The use of the words *'was able to convince me'* indicated that the more junior member of staff may have difficulty in effecting a change in the model selected for actual use due to the nature of their relationship. In addition the use of the phrase *'I would like to think'* also indicated that this situation had not yet arisen in

interviewee 2's experience. Similarly the use of the words '*I would be adaptable enough*' provided a link to the newly emerging sub-category related to a forecaster's personal style or approach.

Interviewee 2 also provided a further element to the emergent sub-category of internal relations when he indicated that it could also be interpreted in the following manner when he said,

'some schemes require a project appraisal that considers capital and revenue costs - this would require us to become involved with using a risk analysis model to assess the potential scheme. Such skills are based in our London head office and so such services could be provided if required here in Bristol'

(tu 199-202)

This data provided evidence of a link between the emerging sub-category of internal relationships and the newly emergent grounded sub-category of intra-organisational resources. The analysis revealed that as yet there was insufficient evidence to fully identify **staff relations** as a separate sub-category within the emerging grounded data-analysis-framework. Such matters would have to be explored by collecting more data from the field.

Summary

The data analysed within this conceptual environment confirmed its relevance to the model selection process. On reflection, the evidence presented indicated that this environment needed to be re-labelled in order to better represent the activities located within it. Accordingly it was decided to re-label this environment as model selection category **(b) data evaluation**.

The analysis of the data allocated within this conceptual environment revealed that the following coding labels had no support, namely, use of data, model data, model understanding, ease of interpretation, and ease of application. Given this lack of relevant grounded data it was apparent that these conceptual model selection criteria were not significant to practitioners in the field. This result indicates that the assertions made about their relevance within the subject specific and general business literature reviewed in chapter 5 to be in error. The reasons for the lack of grounded data related to the sub-category labelled model understanding was discussed in section 6.3.2

It was decided to collapse the coding labels listed above as separately identified sub-categories within the developing grounded data-analysis-framework. Other sub-categories, namely model data, and project type, only had mis-coded data assigned to them. It was decided to re-assign that data to other more relevant sub-categories in the emerging grounded data-analysis-framework. Data assigned to the conceptual label entitled ease of model application were on reflection merged with the data assigned to the emerging sub-category of **experience**.

The sub-categories included in the emerging grounded data-analysis-framework were, (i) **forecasters style**, (ii) **accuracy**, (iii) **experience**, (iv) **judgement**, (v) **risk perceptions**, and (vi) **staff relations**. The continued inclusion of sub-categories (iii) **experience**, and (iv) **judgement** within this conceptual environment needed to be reviewed following the next round of data analysis

Conflicting evidence was presented within this initial round of data analysis about the impact of differing levels of resources available within the organisational settings of the building project price forecasters themselves. There was some evidence from interviewee 1 that the practitioner situated within a smaller sized organisation which provided a narrow range of services to a limited number of clients had constraints upon which tool or model to select. This evidence called for a further data analysis in order to enable its deeper exploration. In addition further evidence would have to be collected from forecasters situated in similar contextual settings as interviewee 2 and 3 who acknowledged that they made only limited use of non-traditional building project price forecasting models and so were suspected as being non-typical of forecasters located in other similar organisational contexts.

Further data also needed to be gathered in order to explore the dimensions of the emerging links between the model selection sub-categories of accuracy, client type, project data, project risks, timescale, organisational structure, and forecaster style. Further data collection and analysis would also reveal the identity of any grounded properties that were relevant to the emerging model selection sub-categories within the data evaluation conceptual environment.

6.3.5 Forecast preparer's organisational environment-category (c)

Fig. 6.3 indicates the coding labels for each of the sub-categories listed within the initial data-analysis-framework that were related to model selection category (c) the forecast preparer's organisational environment

The analysed data collected from interviews 1 - 4 indicated that there was no data assigned to coding label **computers**. Evidence related to this conceptual coding label either was not present within the data or had been assigned to other coding labels.

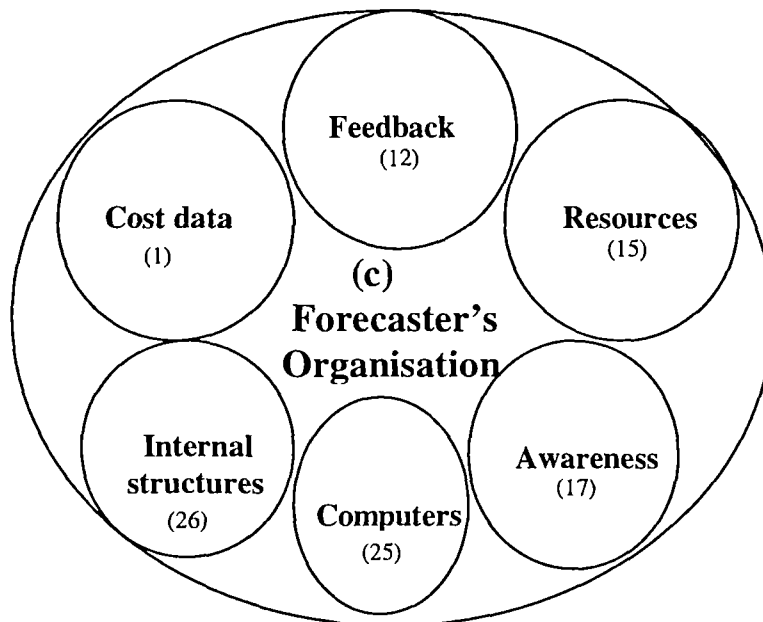


Fig. 6.3 Conceptual environment - (c) forecast preparer's organisation

Cost data

This coding label related to the forecasters access to project cost data within the organisation and its impact on the process of building project price forecasting model selection.

This conceptual label was previously coded within conceptual environments (a) and (b) and facilitated the emergence of project data as a distinct sub-category within the emerging grounded data-analysis-framework.

The relevance and significance of this preliminary conceptual label as an emerging sub-category was indicated by comments from interviewee 1 who said, in relation to the use of statistically based models, *'for similar schemes to help produce early cost advice using this model I think that the amount and availability of past data is a factor that would determine which technique was appropriate to use'* (tu 112-115). The use of the phrase *'for similar schemes'* within the above comment also indicated a potential link between this emerging sub-category and the already emergent sub-category of project type.

Interviewee 1 confirmed the relevance of cost data availability as an emergent sub-category when he went on to say, *'models such as the monte carlo simulation and regression analysis would be more appropriate if I had the data for them'* (tu 141-143). Interviewee 4 indicated quite how fundamental the availability of cost data was and the potential for it to be related to the previously identified emergent grounded sub-categories of project type and the emerging overarching constraint of organisational type when he commented,

'the type of model used depends upon the type of work that the forecasters organisation is involved in. If they are doing less and less traditional work then they will have access to less and less data and so will eventually be unable to provide this forecasting service' (tu 756-759)

The data so far collected and analysed has confirmed the relevance of **cost data** availability as a separate sub-category within the emerging grounded-data-analysis framework although its interrelatedness to other sub-categories has not yet been established. Additional data needed to be analysed in order to allow this to happen.

Feedback

This coding label related to the feedback provided to forecasters on the reliability of the models in-use from past projects and the potential for its variability to impact on the process of building project price forecasting model selection.

The relevance and significance of this preliminary conceptual label as a separately identified sub-category was confirmed by interviewee 4 when he said, *'feedback is important in finding out how accurate the system is and we keep a record of our accuracy'* (tu 505-505). However the lack of any other corroborating evidence from the data assigned to this conceptual label called into question its continued inclusion as a separately identified sub-category in the emerging grounded data-analysis-framework.

Resources and Structure

Following analysis, the data assigned to the above coding labels were found to be related to each other. The coding label related to the organisations resources in terms of staff availability, and the coding label related to the organisations internal staff structure and the relationships between staff. The data collected under both coding labels were then merged and analysed together in order to assess their impact on the process of building project price forecasting model selection.

The relevance and significance of the preliminary conceptual labels indicated above as emerging sub-categories was evidenced in comments from interviewees 1 and 2. Interviewee 1 was a sole practitioner, who did not make practical use of a number of the computer based models listed, and he commented that, *'other factors related to the size and complexity of the project, type of procurement arrangements and size of organisation were issues affecting the choice of particular models'*, (tu 147-151). Such comments indicated that size of organisation in general, and the availability of resources within it, in particular, were issues that constrained the capability of a building project price forecaster to select certain types forecasting of models as tools to aid the price formulation process. The centrality of these findings needed to be explored following the analysis of further data.

These comments also suggested that the grounded data within the merged model selection sub-category identified above would be better represented if it was re-labelled as resource assessment. This sub-category had links to the already emerged sub-category related to project type. The above data also indicated the emergence of some

of project type's related properties, namely, size, and complexity. The comments from interviewee 1 also indicated the potential emergence of a further provisional sub-category namely, procurement type. The relevance of **procurement type** as an emergent coding label needed to be confirmed following further analysis.

The organisational setting of interviewee 2 was different from that of interviewee 1. Interviewee 2 was situated in an organisation which was larger and which offered a wider range of services as compared to the organisational setting of interviewee 1. As such the comments made by interviewee 2 were in contrast to the comments made by interviewee 1. Interviewee 2 agreed to a suggestion that the size of the organisation with its many branch offices assisted in the marketing of the organisation's services and he went on to say,

'yes very much so it is a definite selling point and one of the advantages of us being such a large organisation is the ability to provide such services based on models such as regression analysis, and knowledge based systems from our London base ... otherwise the lack of availability of such expertise and computer equipment are factors that would limit our ability to provide such specialist services' (tu 207-214).

The capability of organisations that have more than one office to select differing building project price forecasting models for use was highlighted in further comments made by interviewee 2 when he said, *'the regional offices have the ability to call on the expertise and skills available at head office'* (tu 254-256). The comment concerning staff expertise indicated a link between this emerging sub-category and the already emerged sub-category of organisational staff relationships. The potential for different price model selection processes between single site and multiple site organisations was also picked up in comments made by interviewee 4. This participant was located in a similar organisation type to interviewee 2 and he commented on the ability to call upon head office skills, facilities, and staff by saying that,

'the ability of our organisation to be able to say that it has the capability to provide a range of cost advice services such as life cycle costs, risk analysis, and value engineering becomes important as a marketing tool. It may well be that quantity surveying is dividing into those organisations that are capable of providing a full range of cost advice services for clients and those that are not' (tu 679-683)

The comments made by interviewee 4 also identified another emerging model selection sub-category that had not as yet been identified and located within the preliminary

conceptual analysis framework. The newly emerging conceptual label was related to the organisations **approach** to marketing its services and it needed to be considered for incorporation into the emerging grounded data-analysis-framework.

The data so far collected and analysed have identified that factors related to **staff and equipment** as well as the **structure** of the organisation in which the building project price forecaster was situated were emerging as separate sub-categories that needed to be included within the emerging grounded data-analysis-framework.

Awareness

This coding label was related to the organisations level of awareness of newer computerised models and the impact of such awareness levels on the process of building project price forecasting model selection.

Confirmation of the significance of this preliminary conceptual label as an emerging sub-category in its own right was provided by comments from interviewee 3 who said, *'I would say that all firms of quantity surveyors need access to such developments... if you can't come up with new ideas or new ways in which they could go about achieving their aims then clients tend to lose interest in your services'* (tu 470-474). The comments from interviewee 3 indicated a potential link between the emerging sub-category of awareness and the emergent coding label of marketing, in that interviewee 3 saw the ability to use the newer computerised cost models as a means of ensuring future business.

The significance of awareness as an emerging sub-category was reinforced by the comments of interviewee 2 who said *'we realised about five years ago that without adapting the ways in which we carried out our work that we would not be in a position to be employed by certain clients'* (tu 464-468). Similarly, interviewee 4 expressed the view that the ability to make use of newer computerised models was, *'central to the services that we offer, without the development of our computerised system our company would have died. We could not exist without it and so from that point of view the time spent in its development was essential time to be found'* (tu 518-521). It was noticeable that interviewee 4 spoke of *'time to be found'* in terms of keeping his

organisation up to date and aware of new developments. Further data collected from building project price forecasters who were situated in differing organisational contexts would reveal whether the ability to find such time was dependent upon the size of the organisation itself.

The above comments have demonstrated that certain types of organisations considered themselves as being forward looking and consequently felt that they had to become aware of the newer computerised cost models that were available in order to maintain their commercial advantage. In addition the above comments reinforced the impact of the emergent sub-category of client demand on the model selection process. However, forecasters in other types of organisation seemed to be less aware and therefore less likely to make use of the newer non-traditional models. This contrast in approach was evidenced by the comments expressed by interviewee 1 who said,

'yes ... I am aware of these newer computer models, but at the end of the day the models are only as good as the information that you put into them. I am somewhat sceptical of the value of computerised data as I think that you have to be aware of the circumstances in which your cost data has arisen'. (tu 131-134)

The data analysed above has confirmed that the broad issues contained within the emerging sub-category of awareness could be re-labelled as approach and included as a separately identified sub-category within the emerging grounded data-analysis-framework. The comments made above also provided some evidence of a link between awareness and the emerging coding label of marketing. However, it was necessary to collect and analyse more data from the field before it was possible to identify or measure any grounded properties of this sub-category.

Summary

The data analysed within this conceptual environment confirmed its relevance to the model selection process. On reflection, the evidence presented indicated that the model selection sub-categories within this environment would be better represented if it was re-labeled to reflect the activities located within it. Accordingly it was decided to re-label this environment as model selection category (c) **resource assessment**.

The analysis of the data allocated within this conceptual environment revealed that the following coding label had no support, namely, computers. The quantitative data collected from the nation-wide survey had indicated that the complete absence of computers was no longer a significant issue amongst the population of quantity surveying organisations. Therefore the subject specific literature that identified the availability of computers as a theoretical selection criteria were now in error. What remains as an issue to be investigated through the analysis of further data collected from the field was what the building project price forecasting organisations actually did with the computers that they had ? For instance did the differing types of quantity surveying organisations make differing uses of their personal computers in terms of using them as intra and inter-organisational resources or simply as stand alone machines which were used for spreadsheet calculations and word processing tasks.

The sub-categories included within the emerging grounded data-analysis-framework were, (i) **cost database availability**, (ii) **feedback**, (iii) **staff /equipment**, (iv) **approach**, and (v) **structure**.

The continued inclusion of sub-category (ii) feedback, within this model selection category (b) needed to be reviewed following the next round of data analysis. The analysed data revealed the following emergent properties of the grounded sub-categories listed above, namely, **marketing, single or multi site structures**, and the extent of relationships between such properties and their sub-categories needed to be established following the collection of further data from the field. The emergent property related to type of **procurement** was, on reflection, re-allocated as a property of the sub-category **client type**. Its continued assignment within model selection category (a) **project awareness** was to be reviewed following the collection of further data.

The analysis of further data would also facilitate the deeper exploration of the significance of contrasting comments from interviewees 1 and 4 which indicated that individual building project price forecasters were limited in the price forecasting models they could select due to their organisational setting.

6.3.6 Forecasting model's environment - category (d)

Fig. 6.4 illustrates the coding labels for each of the sub-categories that were related to model selection category (d) the models environment.

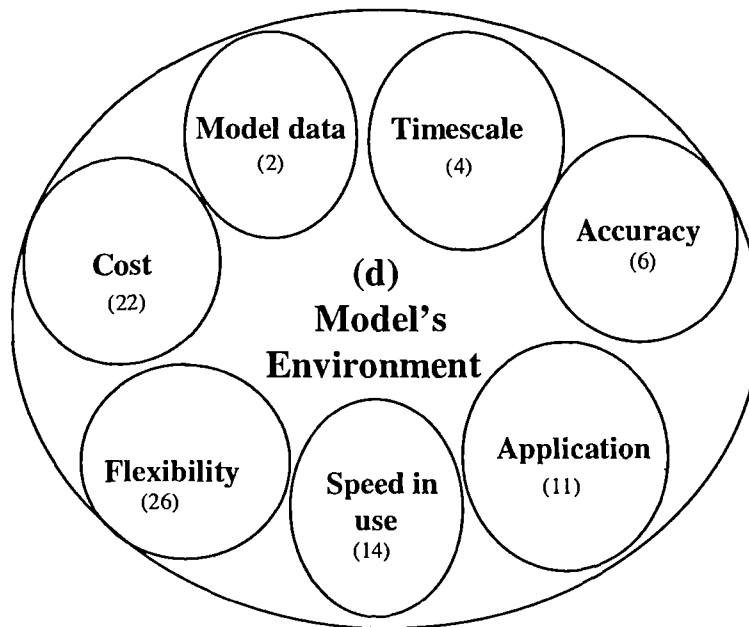


Fig. 6.4 Conceptual environment - (d) the model

The analysed data collected from interviews 1 - 4 indicated that there were no data assigned to coding labels flexibility, and costs. Evidence related to these conceptual coding labels either was not present within the data or had been assigned to other coding labels. It was decided to consider the collapse of the sub-categories indicated above following reflection on the completed analysis of the collected data.

Data for the model

This coding label was related to the availability of data required by the model for its use and the impact of the extent of its availability on the process of building project price forecasting model selection.

A similar coding label had been included in model selection category (b). The data coded here at this coding label were intended to be data needed by the model itself rather than its availability.

However the data analysed within this coding label did not confirm the significance of this preliminary sub-category in its own right as the data assigned to this code was more related to data availability in model selection category (b). Typical of the comments made were the following from interviewee 1, *'I think the amount and availability of past cost data is a factor that would determine which technique was appropriate to use in a given set of project circumstances'* (tu 112-115).

This result indicated that the continued allocation of material under this separate coding label needed to be reviewed before the emerging grounded data-analysis-framework was established and further data analysed.

Timescale

This coding label was related to the availability of time required to operate the model selected for use and its impact on the process of building project price forecasting model selection.

A similar coding label had been included in model selection category (a). The data coded here at this coding label were intended to be data more related to the model itself rather than the speed of response required by the client.

However, the data analysed indicated that the comments made were not in sufficient detail to provide an indication of how long each type of model took to be applied to a given situation. The data assigned to this coding label referred to the general timescale available and its impact on model selection. Typical of the comments made were those from interviewee 4 who said, *'In some circumstances the pressures caused by having only limited time available for a response would preclude the use of our more sophisticated software'* (tu 618-620)

This result indicated that the continued allocation of material under this separate coding label needed to be reviewed.

Accuracy

This coding label was related to the accuracy of the model's output and the impact of its variability on the process of building project price forecasting model selection.

A similar coding label had been included in model selection category (b). The data coded here were intended to be data more related to the output of the differing types of models themselves rather than the forecast preparer's perception of the accuracy levels required by the client.

However the data analysed indicated that the comments made were not in sufficient detail to provide an indication of the accuracy achieved by each type of model. The data assigned to this coding label referred to the general accuracy levels required by the client and its impact on model selection. Typical of the comments made were those from interviewee 3 who said, *'accuracy is the main factor that determines the choice between techniques and it would be expected that the figures produced would be accurate to about 5%'* (tu 618-620)

This result indicated that the continued allocation of material under this separate coding label needed to be reviewed

Application

This coding label was related to the relative ease with which the model could be applied and the impact of its variability on the process of building project price forecasting model selection.

A similar coding label had been included in conceptual environment (b) the forecast preparer at sub-category. The data coded here were intended to be data more related to the ease of model application itself rather than the forecast preparer's perception of the ease with which the model could be applied.

However the data analysed indicated that the comments made were not in sufficient detail to provide an indication of the ease of application appropriate for each type of

model. The lack of data assigned to this coding label indicated that the continued allocation of material under this separate coding label needed to be reviewed.

Speed in-use

This coding label was defined as being related to the relative speed with which the model could be applied and the impact of its variability on the process of building project price forecasting model selection.

The data analysed indicated that the comments made were not in sufficient detail to provide an indication of the ease of application appropriate for each type of model. Typical of the comments made were the following from interviewee 3 who said, '*computers do speed up your performance*' (tu 521). However the lack of other corroborating data assigned to this coding label indicated that the continued allocation of material under this separate coding needed to be reviewed.

Summary

The coding labels of flexibility and cost had no material assigned to them it was initially decided that they could not be real factors affecting the selection of building project price forecasting models. However, on further reflection on the context in which the comments interviewee 1 made in relation to the resource costs of using computerised types of building project price forecasting models it was decided to retain '**costs**' as a provisional coding label.

Coding label 'model data' had data assigned to it which, after reflection on its context, were re-assigned to the already emergent sub-category of **project data**. However, it was thought that this coding label, which was related to the data needs of the model itself rather than the data made available by the forecast user, should be part of an emergent data-analysis-framework together with a further coding label that identified the actual models in use.

Coding labels related to timescale and speed of the model in use, and both were found to have inadequate material assigned to them. However, it was thought that issues

categories indicated above following reflection on the completed results of the analysis.

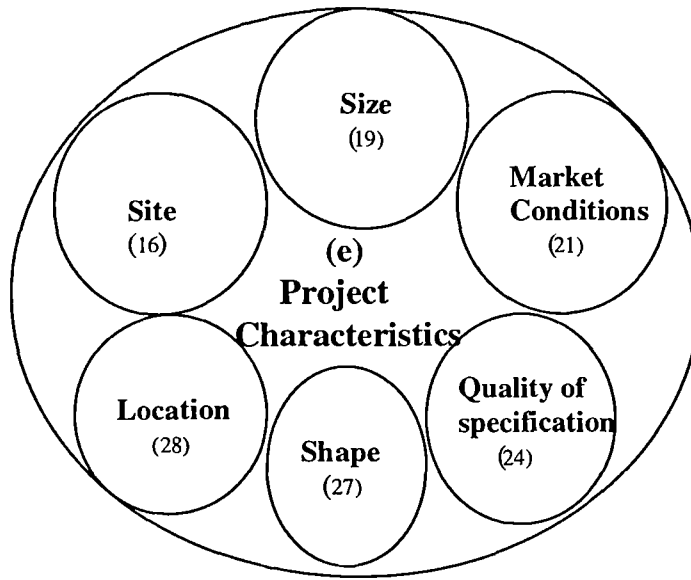


Fig. 6.5 **Conceptual environment (e) - project characteristics**

Size

This coding label related to the relative size of the project and the impact of its variability on the process of building project price forecasting model selection.

Comments from interviewee 1 indicated that in his opinion size of project did not effect the price forecasting model used when he said, '*... projects may vary in size and scope from say a traditionally built simple boat house to a high quality large and complex development. The techniques I would use would be the same*' (tu 13 - 15).

However, interviewee 2 disagreed with the comments made above. Interviewee 2 said, '*... factors such as the size of the project in terms of its complexity and the level of information available have a bearing on whether you would prepare approximate quantities or rely upon costs/m² based on intuition and judgement*' (tu 273-275)

Given the lack of any further corroborating evidence from amongst the data analysed it was resolved to analyse further data in order to determine whether project size should continue to be included as a separate sub-category or as a property of another sub-category within the emergent grounded data-analysis-framework.

Market conditions

This coding label was related to the market conditions prevailing at the time of the forecast production and its impact on the process of building project price forecasting model selection.

The data analysed indicated that the comments made were not in sufficient detail to provide an indication of how the market conditions prevailing at the time of the forecast formulation impacted upon the price forecast model selection process. Given the lack of any other corroborating data assigned to this coding label it was decided to review its separate coding following reflection on the completed results of the analysis.

Summary

The majority of the provisional coding labels within conceptual environment (e) **the projects characteristics**, had no material assigned to them. It was decided not to continue with them as separate sub-categories within the emergent grounded data-analysis-framework.

Coding labels related to size of projects and market conditions, and both were found to have inadequate material assigned to them following the analysis of the data collected from interviewees 1-4. However, it was thought that issues related to project size and market conditions should be part of an emergent data analysis framework and so it was decided to re-assign **project size** and **market conditions** as provisional properties within the emergent model selection category (a) **project awareness**.

Given the lack of adequate material coded within (e), **the project's characteristics**, it was decided to remove it as a separately identified conceptual environment. The data presently assigned within this environment was merged with the data assigned to the already emerged model selection sub-category of **project type**.

The collapse of this model selection category, together with the generally low scores awarded to the criteria such as height, shape, location, and site conditions that made up the model selection category, by the respondents to the quantitative study that was reported in chapter 5 has shown that the subject specific texts that firstly identified such criteria as factors which practitioners used to discriminate between types of building project price forecasting models to be in error.

6.4 The emergent grounded data-analysis-framework and propositional model (1)

6.4.1. Generally

The data collected from interviewees 1 - 4 was analysed above in order to,

(i) establish the validity or otherwise of the coding labels that had been used in the initial indicator data-analysis-framework to represent the selection factors that had been previously identified from the relevant literature.






































and

(ii) identify any new sub-categories of selection factors that were emerging from the first round of grounded data analysis

The completed data analysis results allowed a comparison to be drawn between the twenty-eight model selection criteria that were identified from the literature reviewed and scored for importance by practitioners in the field, and the selection factors that were grounded in practitioners actual experience.

Table 6.4 indicates the extent of the movement away from the model selection criteria that had been identified within the available literature and towards the model selection categories and sub-categories that were grounded in the experience of practitioners in the field. Table 6.4 also illustrates the theoretical criteria that have been included as provisional sub-categories within the emergent grounded-data-analysis framework. The positive model selection criteria shown in Table 6.4 to be non-real criteria, namely, site characteristics, flexibility of the model in use, the design consultants for the project, the anticipated quality levels for the project, the anticipated shape of the project, and its geographic location were identified from relevant subject specific literature which has been proved to be in error. The analysis of further data would also indicate which of the non-critical selection factors shown in Table 6.4 were actually relevant to practitioners. Table 6.4 also indicates the newly emerged grounded model

Table 6.4 Comparative analysis of theoretical and emergent grounded selection criteria (interviewees 1 - 4)

Nr	Potential Model Selection Criteria (Identified from literature)	Model Enviro nment	Critical sub-cat egories	Non- critical/ proporti es of sub-cat egories	Non- real criteria	Emerg ent sub-cat egories
1	Amount of project data available	A				
2	Data needed for model	D				
3	Forecasters understanding of the model					
4	Time available for forecast preparation	A				
5	Project type	A				
6	Accuracy of model output	D				
7	Forecasters experience of model in-use	B				
8	Amount of judgement requ'd for model use	B				
9	Ease of interpreting model output	D				
10	Amount of risk in project decisions	B				
11	Ease of model application	D				
12	Feedback from previous forecasts	C				
13	Nature or purpose of the forecast	A				
14	Speed of the model in use	D				
15	Human resources required to operate model	C				
16	Site characteristics of the project					
17	Level of awareness of new models	C				
18	Flexibility of model in use					
19	Project size	A				
20	Nature of the client	A				
21	Market conditions	B				
22	Cost of using model	D				
23	Design consultants for the project					
24	Quality levels required in the project					
25	Availa'ty of computers for use with model	C				
26	Relationships with forecaster and manager	B				
27	Anticipated shape of the project					
28	Geographical location of the project					
	Client demand	A				
	Forecaster style	B				
	Accuracy perceptions	B				
	Cost database availability	C				
	Resources	C				
	Organisational approach	C				
	Organisational structure	C				
	Model type	D				
	Operational characteristics of model	D				

selection categories and which were omitted as selection factors within the existing literature reviewed in chapter 5.

6.4.2 Propositional model (1)

As a result of the analysis of the data so far collected the major selection categories included within the initial grounded data analysis framework were reduced from five to four and now represented the following model selection categories

- * (a) project awareness,
- * (b) data evaluation,
- * (c) resource assessment,
- * (d) tool applicability

Fig. 6.6 illustrates the emerging grounded data-analysis-framework that contains each of the emerging selection categories (a) - (d). Rivett (1972) indicated that the development of such a model was a convenient way of representing a total experience from which patterns may be deduced. Such patterns could then be used to predict future similar activities. In order to ensure that propositional model (1) had an appropriate orientation it was decided to align each of the model selection categories to form an iterative process which Kolb (1984) maintained was how professionals learn. In particular it was accepted that the iterative phases of feedback and reflection acted in an overarching manner across not only the selection of the appropriate model but also its application. The emergent grounded data-analysis-framework had sub-categories related to experience and feedback within the data evaluation and resource assessment selection categories.

According to Miles and Hubermann (1994) a model was a means by which sets of relationships between controllable and uncontrollable factors could be expressed in a symbolic form that represented an activity and its relevant features. Fig. 6.6 indicates the major features or sub-categories that have been identified as being relevant within each of the selection categories listed above. The collection of more data from building project price forecasters in the field would enable controllable and uncontrollable factors to become identified.

Fig. 6.6 indicates the presence of the factors which were suspected as constraining the building project price forecasting model selection process. The suspected constraints of organisational size and type were evidenced within the contrasting data collected and analysed from interviewees 1 - 4. Therefore propositional model (1) identified that the size and type of organisational setting in which building project price forecasters were situated were major constraints on actual model choice.

In order to establish the reliability of the content of propositional model(1) in terms of the identified categories, sub-categories, and their related properties, as well as the validity of its organisational constraints on model choice, it was now necessary to collect and analyse more data from the field. The collection of further data from a sample of practitioners that had been selected in a purposeful manner would also facilitate the unraveling of the indicated links and inter-relationships between the differing model selection categories illustrated within Fig. 6.6

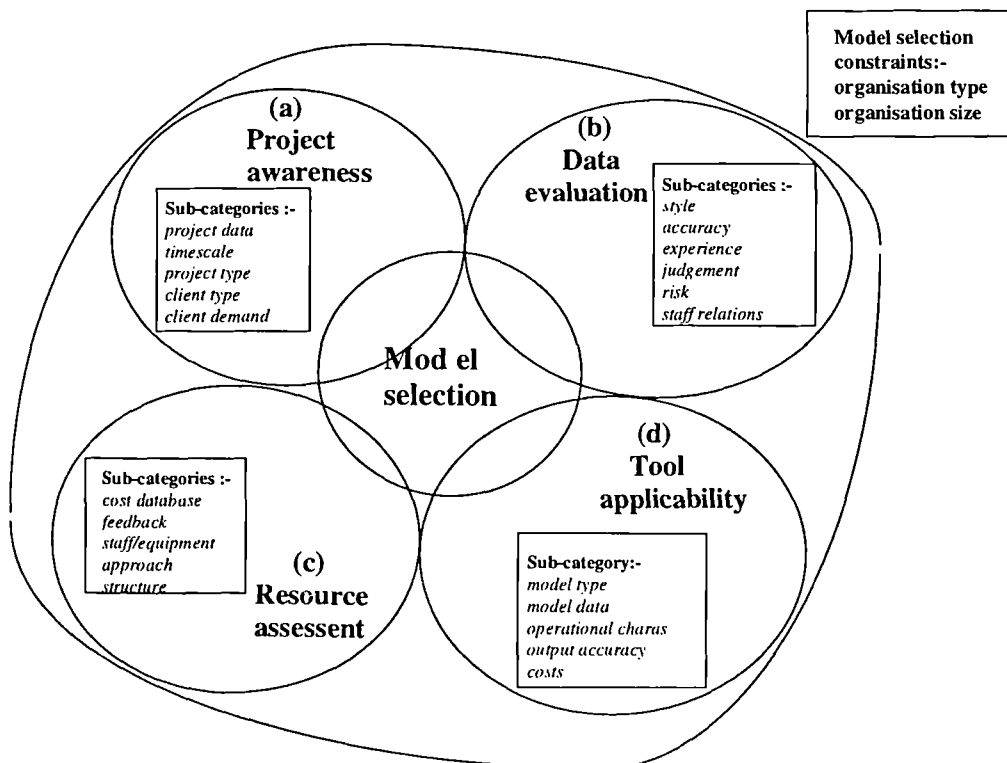


Fig 6.6 Initial propositional model (1) of the building project price forecasting technique selection process

6.5 Summary and reflections on the research process

6.5.1 Summary

This chapter reported the initial exploration of the territory associated with the factors thought to affect the building project price forecasting model selection process. The chapter firstly set out the underlying philosophical standpoint from which the exploration of the issues related to why and how practitioners selected different models for use, was executed. Such an investigation needed to reflect a rigorous approach to the purposeful selection of informants for the study and this was able to be achieved as a result of the nation-wide survey. An initial round of interviews with building project price forecasters in the field was undertaken and the data collected were analysed with the NUD*IST4 software package. The rigorous adherence to accepted good practice procedures in terms of data collection and analysis ensured that the results of this initial exploration of the territory were reliable. As such the results reported in the chapter could be used as a grounded basis from which further successive explorations of the model selection process could be shaped and bounded.

An initial indicative conceptual model of the price forecasting technique selection process had been developed on a theoretical basis from the literature previously reviewed. Such a model had facilitated the development of an indicative proposition that sought to establish an explanation of the factors involved in the actual model selection process. This chapter addressed the initial steps involved in the grounding of a proposed selection theory in practitioners actual experiences.

The analysed data provided evidence that either confirmed or did not confirm the selection criteria that had been identified from the literature reviewed in chapter 5. The analysis process had facilitated the emergence of grounded model selection categories that were illustrated in Fig. 6.6. The initial round of data collection also provided some qualitative evidence of the existence of overarching model selection constraints that were related to size and type of organisation that affected the types of building project price forecasting models selected for use.

6.5.2 Implications for further work

The work undertaken above has started to re-define the boundaries of existing knowledge on the factors that affect the building project price forecasting selection process. It developed a set of propositional model selection criteria that now needed to become fully grounded in practitioner experience. The confirmation of the grounded model selection categories advanced above was seen as a necessary further step in the work.

In addition the research needed to collect further data in order to begin to address the unraveling of relationships between groups or clusters of selection categories and the types of building project price forecasting model actually selected for use.

The work undertaken so far with practitioners in the field was guided by the indicative proposition that was set out in chapter 5, and which postulated that,

'the selection of particular building project price forecasting models depended upon the interrelationship of (a) the forecast user's needs, (b) the forecast preparer's skills, (c) the forecasting organisations resources, (d) the forecast model's attributes, and (e) the proposed projects characteristics, and factors related to organisational size, type, and ratios of staff to computers'

The indicative proposition set out above was developed following the quantitatively based work which sought to confirm the existence and relevance of the model selection criteria that had been identified from by existing literature. The qualitatively based work reported in this chapter has enabled a re-focused proposition to be developed that was used to guide, focus, and bound further exploration. Proposition (1) was set out as follows,

'The selection of particular building project price forecasting models is an iterative process that depends upon the interrelationship of factors related to the building project price forecaster becoming aware of the project, evaluating relevant input data, assessing available resources, and selecting the most applicable tool within the constraints of organisational size and type'

The activities undertaken to confirm proposition (1) set out above have been reported in the following chapter.

6.5.3 Reflections on the research process undertaken

The change in research paradigm dictated by the combined sequential research approach adopted for the work together with a growing understanding of the dynamic nature of the problem being investigated required the researcher to change philosophical viewpoint from that which had guided the earlier part of this work. Such a shift proved to be personally challenging and caused the researcher to fundamentally re-appraise the value of previous research undertaken from the positivist viewpoint.

The change of research direction called for at this stage required the researcher to re-appraise his views in terms of ontology, epistemology, and methodological choice. The absorption of what had previously been unabsorbed philosophical argument took some time to achieve. The research log of this period recorded a gap of seven months between the execution of the quantitative study (reported in phase 1) and the first attempts to enter the field in order to collect more qualitative data. This record in the research log provided evidence of the iterative process of study, debate, and philosophical discussion with others, which was necessary in order to allow the researcher to become more aware of the interpretivist research viewpoint.

The activities involved in the execution of the research undertaken in connection with the work reported in this chapter have provided a valuable lesson in the mechanics of carrying out a qualitatively based investigation. In particular the reasoning and justification process associated with informant selection was valuable as was the experience gained in carrying out face-to-face interviews. The financial support provided by the RICS Educational Trust was appreciated at this critical phase of the study and it was felt that its contribution added to the potential of the work to achieve valid results.

The challenge of undertaking a qualitative data analysis called for the researcher to become familiar with the merits and demerits of differing software packages that were available. As a result the researcher developed new data analysis skills and the researchers home institution obtained its first copy of the NUD*IST4 software package. The requirement on the researcher to 'tell the story' when writing up the

results of the qualitative investigation also proved to be a demanding task. The academic struggle involved in the achievement of that task provided an opportunity for valuable skills in written communications to be developed.

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Chapter 7

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Chapter 7

Propositional Models of the Factors Affecting the Selection of Building Project Price Forecasting Tools

7.1 Introduction

7.1.1 Generally

Chapter 6 reported the results of the initial exploration of the factors used by practitioners to select types of building project price forecasting models. This chapter examines the appropriateness of the propositional categories of selection factors that had been developed as a result of previous data analysis and explores the additional data collected for evidence of potential relationships across and within the emerging categories of model selection factors. The chapter starts by providing a rationale for the selection of the interviewees included in this round of data collection. Following data analysis the chapter reports only the changes to the emergent grounded data-analysis-framework and the impact of these changes on the emerging sub-categories and their related properties. A further two propositional models are advanced within the chapter which ends with the initial exploration of relationships between the data sets analysed from interviewees 1-14.

The chapter has been structured firstly, to reflect the phases of activity involved in confirming the emerging categories and sub-categories of model selection factors and then secondly, to reflect the initial exploration of the data for evidence of relationships amongst the confirmed or grounded categories of model selection factors themselves.

This round of data collection was with interviewees 5-9 and information related to their selection is provided below.

7.1.2 Selection rationale for interviewee's 5 - 9

The second round of interviews (5-9) were conducted in the late summer of 1997.

Section 6.2.4 sets out the general rationale and procedures used to select and contact the potential interviewees for the study. Table 6.2 indicated that the general selection rationale from which interviewees were selected required them to have practical experience in at least three of the six newer types of non-traditional building project price forecasting models. The rationale for the selection of interviewees for the second phase of data collection was also guided by the practitioners selected as interviewees 1-4. Data needed to be collected from price forecasters that were located in different types and sizes of organisations from those that had previously been contacted and data also needed to be collected from forecasters located in similar organisational types and sizes in order for it to be compared and contrasted with the data previously collected.

The analysis of the data reported in chapter 6 indicated that there were significant differences between the approaches adopted by interviewee 1 and interviewee 4. Interviewee 4 was situated in a large sized project management type organisation. Therefore it was decided to contact a further interviewee from the nine confirmed participants who were situated in that organisational setting. Each were contacted and respondent 230 agreed to become interviewee 5.

Table 6.2 indicated that the major proportion of confirmed participants in the study were situated in quantity surveying practices that employed between two and five members of staff in the building project price forecasting process. Interviewee 3 had been situated in this setting and so it was decided to collect data from another interviewee from that type of organisational setting in order to be able to make a within-case data comparison. Each of the six confirmed participants who were situated within that type of organisation were contacted and eventually respondent 263 agreed to become interviewee 6.

Three of the confirmed participants had styled themselves as being situated in either a multi-disciplinary or a project management type of organisation in which only one member of staff was involved in the building project price forecasting process. Only respondent 924, matched the requirements set out in Table 6.2 and so he became interviewee 7.

The data collected from interviewee 2 revealed that he did not have the previously claimed practical experience of the differing types of forecasting models that were available. Interviewee 2 was situated within a multi-disciplinary type of organisation in which between six and ten employees were involved in the building project price forecasting process. Therefore it was decided to obtain further data from the confirmed participants within this contextual setting. Respondent 1701 was one of the four confirmed participants within this organisational type and he became interviewee 8.

Eleven confirmed participants had styled themselves as being situated in quantity surveying practices in which between six and ten employees were involved in the building project price forecasting process. Of those organisations only five claimed to match the selection requirements set out in Table 6.2. Each were contacted and access was agreed with respondent 2492 who became interviewee 9.

The first round of meetings (interviews 1-4) had adopted an unstructured, in-depth, non-directive approach. As a result of the data collected and analysed from interviewees 1 - 4 it had been possible to develop a grounded data-analysis-framework and propositional model (1). The categories and sub-categories within propositional model (1) were now used to guide and focus the tape recorded conversations with interviewees 5 - 9. The taped conversations with interviewees 5 - 9 lasted on average forty-five minutes. The full transcripts of the taped conversations can be viewed in the relevant NUD*IST4 document file on the disc attached at the rear of the document.

7.2 Propositional model (1) and emergent data analysis

7.2.1 Generally

Section 6.4 developed an initial grounded data-analysis-framework for propositional model (1) from the data collected and analysed from interviewees 1 - 4 - see Fig. 6.6. The initial grounded data-analysis-framework had four main categories of model selection factors within which a number of emergent sub-categories were situated. The conceptual labels applied to each of the main categories of model selection factors advanced in propositional model (1) were,

- * (a) *Project awareness*
- * (b) *Data evaluation*
- * (c) *Resource assessment*
- * (d) *Tool applicability*

The data collected from interviewees 5 - 9 were entered into the NUD*IST4 data analysis software package and were analysed to,

- (i) *confirm the appropriateness of the main model selection categories, their sub-categories, and to identify any of their emerging properties*

The full results of the analysis together with the index tree lists and tree display diagrams used with the analysis of the data collected from interviewees 5 - 9 have been presented in appendix 4.

Readers note - only data that justified changes to categories of model selection factors in terms of their continued inclusion, content, or labelling has been considered below. The majority of the data collected and analysed from interviewees 5 - 9, which were confirmatory in nature have not been presented here.

The diagrams included at the start of each section of data analysis reflect the emerging sub-categories and their properties which were included as nodes in the NUD*IST4 software data analysis package. Sub-categories shown in the diagrams without any attached properties have been included as provisional sub-categories for the purposes of analysis.

7.2.2 Project awareness - model selection category (a)

Fig. 7.1 illustrates the sub-categories and their existing provisional properties which together constituted model selection category (a) - project awareness. The sub-

categories indicated were included as nodes within the emerging grounded data-analysis-framework.

The amount of data assigned to each of the sub-categories of model selection factors illustrated in Fig. 7.1 confirmed the retention of **project data**, **timescale**, **project type**, and **client demand** as sub-categories within this main category of model selection factors and so were retained as 'nodes' in the revised data-analysis-framework associated with propositional model (2).

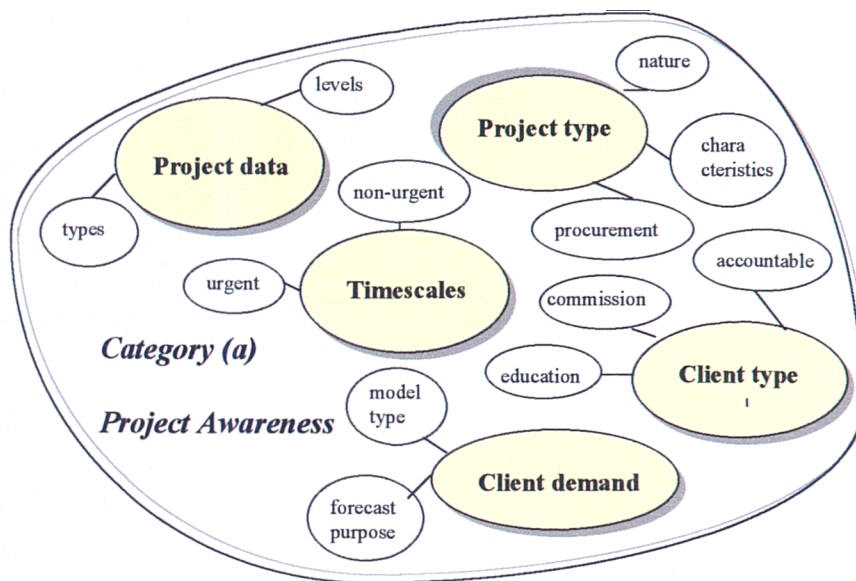


Fig 7.1 Category (a) - Project Awareness in propositional model (1)

The data were further sifted within the NUD*IST4 software package to either confirm the appropriateness of the properties that had been provisionally applied to each of the sub-categories listed above or to detect the emergence of any new properties that needed to be incorporated into the revised grounded data-analysis-framework. Each of the sub-categories have now been considered in turn below.

Project data

There was some evidence of different views on the relevance of the provisional properties of 'types' and 'level' that were assigned to this sub-category. Typical of the comments made in connection with this sub-category were the following, *'the main things that affect the type of model used is the quality of the information available*

about the project and the timescale for our response' (int5 tu124), and *'if I had to say which was more important then I would say that the level of information was the main factor affecting the choice of model for use'* (int 5 tu 273-274)

Interviewee 9 dissented entirely from the general view when she commented, *'the way the forecast was produced would basically be the same whatever the level of information produced'* (int 9 tu 149-150). The same view was held by interviewee 7. It was later revealed that both interviewee 7 and 9 used only a limited range of forecasting models. Further analysis was required in order to determine whether such views were typical or non-typical.

The data analysed within this sub-category revealed evidence that practitioners discriminated between models on the basis of the level of design information generally available, and the existence and extent of any available drawn information. It was decided to incorporate **verbal**, **written**, and **drawn** types of data as emerging properties within the revised grounded data-analysis-framework.

Timescale

Conflicting evidence was found on the impact of timescales on the building project price forecasting model selection process. Typical of the comments made were, *'I have found that the main thing that affects the type of cost model I would use is the quality of the information available and the timescale available for us to respond'* (int 5 tu 123-125) Interviewee 6 took a more negative line in terms of the consequences of time as a factor in the model selection process when he commented, *'the pressure caused by the timescale available to us would not cause us to alter the techniques used to provide early cost advice'* (int 6 tu 495-497). Further analysis was needed to confirm which of those views were the more typical of the majority of the interviewees.

The provisional properties of **urgency** and **non-urgency** were confirmed as being relevant properties of the sub-category of timescale as a result of the data analysis. Conflicting views on its impact can be evidence in the following, *'we can produce early cost advice with our causal cost models within half a day and that is usually*

more than acceptable' (int 6 tu 516-518) and *'if a client were to say that the initial forecast was to be produced by the end of the day then you may have no option but to use a cost/m² model'* (int 9 tu 96-98). When the response required was non-urgent then the general approach taken was, *'you would look at the building in more detail and you may well elect to form your forecast by taking approximate quantities or by using the BCIS elemental analysis'* (int 9 tu 107-108).

This response in terms of the models chosen when time was short was surprising as one of the perceived advantages of using computerised cost models in lieu of traditional manual models was their relative speed in-use. This was a matter to be re-considered following the collection of more data. Therefore **urgent** and **non-urgent** were retained as emerging properties within the sub-category labelled **timescale**.

Project type

The following comments provided evidence of conflicting views on the suitability project type as a sub-category in the emerging data-analysis framework *'due to the nature of the project I cannot use ELSIE, or the BCIS elemental analysis method as they do not deal with one-off projects'* (Int 5 tu 143-146), and *'no ... the techniques I use would hold good from the smallest to the largest project '* (int 6 tu 471-472). This conflict in views between interviewee 5 and interviewee 6 was suspected as being a reflection of the differing range of models that they each had available to them. Nonetheless this conflict needed to be explored in further data collected from the field. The amount and context of other data assigned to this sub-category indicated that project data should be retained as a sub-category within the revised grounded data-analysis-framework.

The provisional properties assigned to this sub-category included nature, characteristics, and procurement. Data analysed supported the continued inclusion of **nature** as an emerging property of this sub-category. Typical of the comments made were those from interviewee 5 who said, *'if the project were a one-off then it would not be worth our while using a causal cost model'* (tu 205).

The provisional property related to the physical characteristics of the proposed project was not seen as being relevant to the price forecasters in the field. Interviewee 5 commented, *'I cannot see how details such as these would cause me to use a particular technique'* (int 5 tu 267). However it was intuitively felt that aspects of the proposed projects characteristics would cause practitioners to select differing models for use. Comments from interviewee 9 supported this view, namely, *'if we are asked to provide advice on large often prestigious projects then we would have to provide our early cost advice in a completely different way'* (int 8 tu 315-317). Therefore it was resolved to include a more broadly based provisional property within this sub-category that was related to **project status** in terms of its prestige or significance as a proposed project. This provisional property was to be reviewed following the analysis of more data.

Conflicting evidence was collected on the impact of the method of project procurement on the building project price forecasting model selected for use. For instance *'no, the change in procurement patterns has not caused us to change the models we use for price forecasting'* (int 6 tu 537-539) and, *'a consequence of that change in procurement towards the use of design and build has been that the data can be better modelled due to the greater degree of repetition'* (int 8 tu 633-635). Notwithstanding this conflict it was decided to retain **procurement** as a separate provisional property within this sub-category of model selection factors and review its continued retention following the analysis of more data.

Client type

The absence of any analysed data related to clients accountability or the nature of their business resulted in this provisional property of the sub-category client type to be removed from the revised data-analysis-framework.

However, issues related to whether the client was new or existing, or whether the client was sophisticated or uneducated in outlook did emerge from the data analysed within this sub-category. Typical of the comments made were, *'we are constantly trying to educate clients to look to the future but I'm afraid they only wish to see the tip of the iceberg.'* (int 5 tu 246-247). The following comments from interviewee 9 revealed

that the status of the client in terms of whether the client was new or existing also impacted on the building project price selection process, namely, *'if an existing client were to approach you to prepare a forecast then the model you would select would be...'*, *'... such an approach would not be possible with a new client'* (int 9 tu 85-91) Given the context of these comments it was decided to re-label the emerging properties within this sub-category as **client status** and **client sophistication**.

Another issue that emerged strongly from the analysed data related to the basis upon which the building project price forecaster was **commissioned**. Interviewee 5 commented *'much as we would like to we are not in a position to provide services such as risk analysis, value engineering or life cycle costs unless we are going to get paid to do it'* (int 5 tu 93-95) Interviewee 8, who employed a wide range of models provided evidence of a much different approach when she said, *'I can't imagine a situation in which we would not make use of risk analysis techniques if the project circumstances required it to be done'* (int 8 tu 487 - 489) It was decided to review the status and location of this newly emerging property once the analysis of the data collected from interviewees 5 - 9 was complete.

Client demand

The provisional properties of this sub-category related to issues such as model demand and the purpose of the forecast itself. The data analysed provided many instances of client demand affecting the model chosen for the formulation of building project price advice. For instance the following comments from interviewee 5 were typical, *'we had been specifically asked to provide a risk analysis for a project'* (int 5 tu 236). Given this evidence it was decided to retain **model type** as an emerging property within the revised grounded data-analysis-framework.

A further property which emerged from the data associated with this sub-category was highlighted in the comment *'another factor affecting early cost advice preparation is what we think the cost information is going to be used for'* (int 6 tu 378) It was decided to re-label this emerging property to reflect a more broadly based property of forecast context in the revised grounded data-analysis-framework. Given the changed nature

of the emerging properties within this sub-category it was decided to re-label this sub-category as **service** and retain it as a separate sub-category within model selection category (a).

7.2.3 Data evaluation - model selection category (b)

Fig. 7.2 illustrates the sub-categories and their provisional properties of model selection category (b) - data evaluation that had been included as nodes within the emerging grounded data-analysis-framework. The amount of data assigned to each of the sub-categories listed above did not confirm that the sub-categories as illustrated were sufficiently grounded to include them, as they were in the revised data-analysis-framework associated with propositional model (2).

The data were further sifted within the NUD*IST4 software package to detect the emergence of any new properties within each of the sub-categories included in this model selection category. Each of the sub-categories have now been considered below

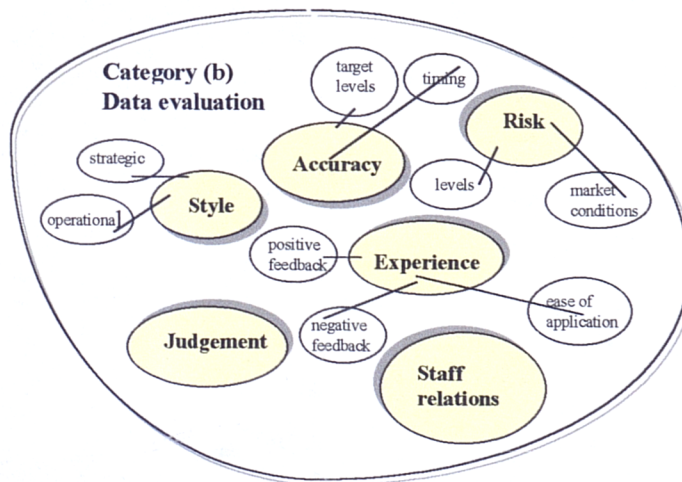


Fig. 7.2 Category (b) - Data evaluation in propositional model (1) Forecasters style

There was no support for the properties assigned to this sub-category. Data assigned to this sub-category when re-analysed revealed newly emerging properties related to

the forecasters own level of expertise and approach to the use of non-traditional building project price forecasting models as well as the organisations approach to or awareness of new technology. Typical of the comments made in relation to this sub-category were the following made by interviewee 7, who said, *'in order to set up and use computerised forecasting models there needs to be time and expertise found and that is something that is not always available in small organisations'* (int 7 tu 200). These comments indicated a potential difference in approach between organisations of differing sizes and needed to be investigated further following the analysis of more data.

Following reflection on the context of the data assigned to this sub-category it was considered that the coding label related to forecasters style was too narrowly drawn to ensure that data from each interviewee could be assigned to it. Following the methodology advanced by Strauss and Corbin (1990) it was decided to consider re-labelling this sub-category at a higher conceptual level. Given the emerging properties related to approach and in particular the proactive or reactive stance that was often implicit in the context of the data analysed it was resolved to include a coding label entitled '**approach**' as a provisional model selection sub-category together with provisional properties labelled '**proactive**' and '**reactive**' in the revised grounded data analysis framework associated with propositional model (2). The continued retention of this provisional sub-category needed to be reviewed following the analysis of further data.

Accuracy levels

In general there was sufficient evidence to retain **accuracy** as a sub-category in the revised grounded data-analysis-framework and propositional model (2). Typical of the comments made were the following from interviewee 8 who said *'the client remembers the first figure presented and so I do think that accuracy is very important'*, (int 8 tu 415). The lack of support for either of its provisional properties, namely target levels and timing, was a matter of some concern given the significance given to accuracy as a factor used by practitioners to select building project price forecasting models. Accordingly it was decided to sift the data assigned to this sub-

category in order to detect any newly emerging properties. Comments from interviewees 6 and 7 indicated that the parameters of acceptable accuracy levels were often related to '*the model selected for use*' itself (int 7 tu 214) and the nature of the forecast being prepared as '*to some clients accuracy did not matter*' (int 9 tu 102). Given the context of these comments it was decided to include the accuracy of the **forecast model** as well as the accuracy required for the **project** as emerging properties within this sub-category in the revised data-analysis-framework associated with propositional model (2) .

The literature reviewed in chapter 5 had indicated that the timing of the request for a building project price forecast itself would be a factor which affected the model selection process. It was resolved to include a further provisional property entitled '**timing**' within the sub-category of timescale in the revised data-analysis-framework. Its continued retention needed to be reviewed following the collection and analysis of further data.

Experience

The data assigned to this sub-category reflected the impact of feedback on the model selection process. Typical comments were, '*we have found that computerised models tend to produce early cost advice in terms of a range of possible prices and we have found that clients do not want their information on that basis*'. (int 9 tu 165). Given the context of the comments made in relation to this sub-category it was decided to re-label it as '**feedback**' and maintain it as a sub-category in the revised grounded data-analysis-framework associated with propositional model (2). Further sifting of the data assigned to this sub-category indicated that its newly emerging properties were related to **output** and **application** and so it was decided to include them as provisional properties within the re-labelled grounded model selection sub-category of feedback. The continued retention of this provisional sub-category needed to be reviewed following the analysis of further data.

Judgement

No data were assigned to this sub-category. Following reflection on this result it was decided to omit judgement as a separate sub-category within the revised grounded data-analysis-framework. Any further data referring to judgement would be assigned to the newly emerged sub-category of 'approach'

Risk

The data assigned to this sub-category revealed that the interviewees interpreted risk as being related to either the basis upon which they had been appointed or as their own perceptions of the risks involved in producing the forecast itself. Typical comments were the following, *'the reality of commercial life is that if you refuse to work on the basis of risk then the client will contact the next surveyor who will be more prepared to work at their own risk'*, (int 9 tu 135-137). Following reflection on the context in which the data had been assigned to this sub-category it was decided to collapse risk as a separate sub-category within the revised grounded data-analysis-framework. It was decided to re-assign the data coded to this sub-category either within the newly emerging sub-categories of culture or commission depending upon the context in which they were made.

Staff relations

The data assigned to this sub-category indicated that staff relations did impact upon model selection, especially in terms of the relationship between senior and junior members of staff. Typical comments were, *'if an associate partner decides that an approach that a more junior member of staff wants to adopt is inappropriate then the proposed approach is knocked on the head...'* (int 9 tu 46). Although the evidence presented did indicate that this issue impacted on the model selection process it was decided that it was an issue that was more related to organisational structure, and personal approach. It was decided to re-assign the data related to this issue within the revised grounded data-analysis-framework as a property within the newly emerging sub-categories of culture and approach.

Summary

This analysis confirmed that category (b) data evaluation should be retained as a separate category of model selection factors within the revised grounded data-analysis-framework associated with propositional model (2). However, the evidence presented as a result of this current round of data analysis called into question the continued identification of the following as separate model selection sub-categories, namely, judgement, risk, and staff relations. Following reflection on the completed data analysis from this round of interviewees it was decided to include the following as revised model selection sub-categories within the revised grounded data-analysis-framework, namely **approach**, **accuracy**, and **feedback**. It was also decided to introduce a new sub-category entitled '**commissioning**'. This was an issue that had emerged strongly from the data analysed at client type in model selection category (a) and so it was decided to include it within model selection category (b) on a provisional basis together with its properties of '**fee basis**' and '**risk basis**'

Given the re-orientated nature of the sub-categories within this main model selection category it was decided to re-label it as **(b) response evaluation** in order to better reflect the nature of the data it contained. It was resolved to review the revised model selection sub-categories and their provisional properties within this re-labelled selection category following the analysis of more data.

7.2.4 Resource assessment - category (c)

Fig. 7.3 illustrates the sub-categories and their provisional properties which constituted model selection category (c) - resource assessment and which were included as nodes within the emerging data-analysis-framework associated with propositional model (1). The amount of data assigned to each of the sub-categories listed above did not confirm that the sub-categories, as listed, were sufficiently grounded to include them as they were in the revised data-analysis-framework.

The data were further sifted within the NUD*IST4 software package to detect the emergence of any new properties within each of the sub-categories included in this model selection category. Each of the sub-categories have now been considered below

Cost database

This sub-category was provisionally included in the data-analysis-framework in order to assess the impact of extra and intra-organisational cost data availability as a factor that affected the model selection process. The first issue to address was whether the organisations within which the interviewees were situated had access to their own cost data bases.

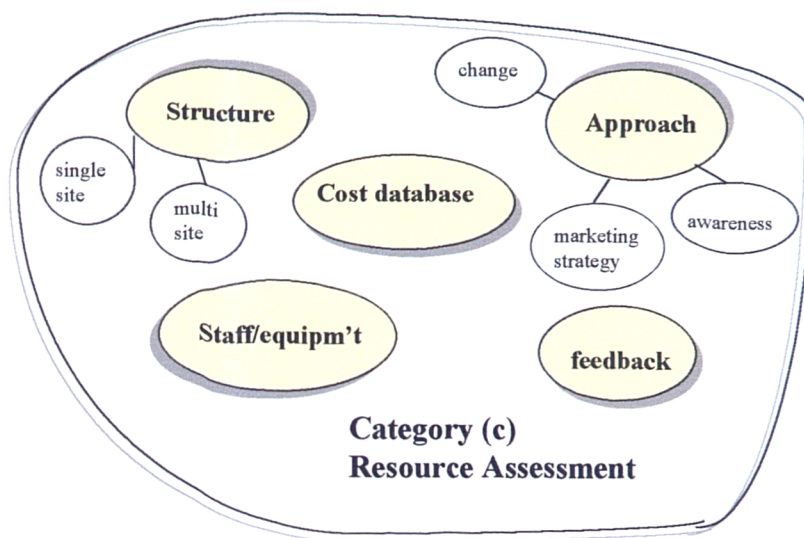


Fig.7.3 Category (c) Resource Assessment in propositional model (1)

Conflicting views were found in the data analysed. A different approach was indicated by interviewee 7 and 9. Interviewee 7 acknowledged that he did not have access to an in-house cost database and used '*an appropriate rate from price books and other published cost sources*' (tu 143-145). The absence of an internal cost database affected the ability of interviewee 7 to make use of all but the most conventional of the traditional building project price forecasting types of models. However, the existence of an internal cost database did not necessarily result in the forecaster being able to make use of the newer computerised types of price forecasting models. For instance, interviewee

9 acknowledged that she made no use of the newer computerised types of price forecasting models and yet she commented '*we keep our own records from all schemes across the organisation.....this data allows us to model data about past schemes that we are familiar with and therefore confident in*' (tu 287-289). Interviewee 5 indicated that he had made practical use of risk analysis, life cycle cost models, and causal cost models and yet he acknowledged that his organisation had '*not been as diligent as we might in keeping and recording cost information from our previous schemes ... we are now in the process of converting our stored data into computerised records that will provide us with data to use as the basis of our forecasts in the future*' (int 5 tu 287-289).

These contrasting views indicated the ability to use an internal cost database did have an effect on the model selection process and as such **cost databases** should be retained as a separate sub-category within the revised grounded data-analysis-framework. The evidence presented indicated that the emerging properties related to cost databases included matters related to whether it was extensive or limited in its nature. It was resolved to adopt **extensive** and **limited** as properties of this retained model selection sub-category.

Feedback

The lack of analysed data assigned to this provisional sub-category resulted in feedback being omitted as a separate sub-category within model selection category (c) - resource assessment. The context of the comments made in relation to feedback indicated that the interviewees saw feedback in terms of it evaluating their responses to a clients needs. Therefore the data coded at this label was re-assigned to the emerging sub-category of feedback within model selection category (b) response evaluation

Staff / equipment

The analysed data assigned to this provisional sub-category revealed that its emerging properties related to the ratio of staff to computer workstations and the availability of staff expertise within an organisation.

Interviewee 7 had no access to a personal computer and so this affected his ability to use the non-traditional range of price forecasting types of model. The other interviewee's had access to computers on a 1:1 or 2:1 ratio between staff and workstations. The evidence assigned to this sub-category indicated that on its own access to computer workstations was not enough to affect the model selection process. The ability of an organisation to make use of staff expertise was indicated in comments from interviewee 5 who said, *'I think that the capability of an organisation to call upon expertise within each of its offices is important'* (int 5 tu 109-110).

However, the lack of other meaningful data assigned to this sub-category indicated that its continued inclusion as a separate model selection sub-category needed to be reviewed. Following reflection it was decided to re-allocate this data to a new provisional model selection sub-category when the data analysis for this model selection category was completed.

Approach and Structure

The data analysed in connection with the model sub-categories listed above were found to be not supportive of their continued inclusion as separate model selection sub-categories within the revised grounded data-analysis-framework. Following reflection it was decided to re-allocate the data coded at this label when the data analysis for this model selection category had been completed.

Summary

The analysis of the data gathered from this round of interviewees indicated that model selection (c) - **resource assessment** should be retained within the revised grounded data-analysis-framework associated with propositional model (2). However the data analysed did not support the retention of following model selection sub-categories, namely, feedback, approach, and structure as separate model selection sub-categories. On reflection and after taking account of the context of the analysed data it was decided to develop a more wide ranging model selection sub-category related to organisational **support facilities** which had provisional properties related to **computer**

networks and **staff structure** in the revised grounded data-analysis-framework. The continued retention of this provisional model selection sub-category needed to be reviewed following the analysis of further data.

7.2.5 Tool applicability - category (d)

Fig. 7.4 illustrates the provisional sub-categories of model selection category (d) - resource assessment that were included as nodes within the emerging data-analysis-framework associated with propositional model (1). The amount of data assigned to each of the provisional sub-categories listed above did not confirm that the sub-categories as listed were sufficiently grounded to include them as they were in the revised data-analysis-framework associated with propositional model (2).

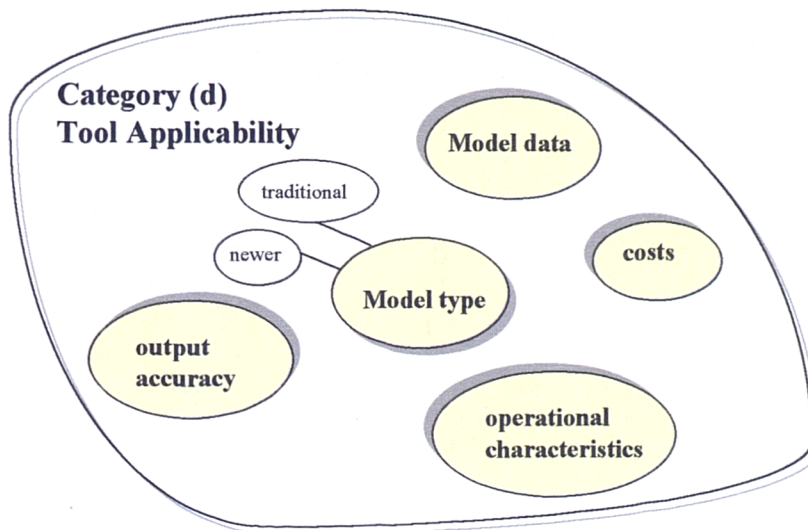


Fig.7.4 Category (d) - Tool Applicability in propositional model (1)

No data were assigned to the provisional sub-categories of model output accuracy and model costs of operation and so they were omitted from the revised data-analysis-framework associated with propositional model (2). Each of the sub-categories listed have now been considered below,

Model type

The data analysed from interviewees 5- 9 revealed that the following models were in use, namely, traditional models such as judgement, costs/m2, approximate quantities, BCIS elemental analysis, (ints 5,6,7,8,9), and newer computerised models such as 'causal cost models, expert systems such as ELSIE, life cycle cost models, risk analysis, monte-carlo simulation, and value engineering' (ints 5,6,8)

The context for the use of the models listed above and the criteria which influenced their use have been identified and discussed in the sections above. The evidence in those earlier sections together with the data assigned to this coding label indicated that **model type** should be retained as a property. The context of the analysed data indicated that it should be attached to the newly emerged sub-category of service demand in the revised grounded data-analysis-framework.

Model data and Operational characteristics

The data analysed in connection with both of the sub-categories indicated above were inadequate to support their continued inclusion as a separate sub-categories within the revised grounded data-analysis-framework associated with propositional model (2). Following consideration of the context in which the comments were made it was decided to merge the data associated with these coding labels with the model selection sub-categories labelled cost database and support facilities which were retained sub-categories within the revised. data-analysis framework

Summary

The lack of data generally assigned to the provisional model selection sub-categories coding labels that made up category (d) tool applicability did not justify its retention in the revised data-analysis-framework associated with propositional model (2). Model selection category (d) was therefore omitted.

7.3 Propositional model (2) and emergent data analysis

7.3.1 Generally

As a result of the data analysed from interviewees (5-9) the four main categories of model selection factors that were included in propositional model (1) changed from being, (a) project awareness, (b) data evaluation, (c) resource assessment, and (d) tool applicability to

- * **(a) project awareness**
- * **(b) response evaluation**
- * **(c) resource assessment**

Fig 7.5 illustrates the main categories of selection factors that were now incorporated into a revised data-analysis-framework and expressed as proposition (2).

7.3.2 Proposition 2

In order to shape, focus, and bound further explorations of analysed data it was necessary to re-define the working proposition so as to reflect the results of the data analysis reported above. Accordingly the propositional model illustrated in Fig. 7.5 was developed to reflect the three main categories of model selection factors, namely, project awareness, response evaluation, and resource assessment, together with their respective sub-categories which were grounded in the data so far collected. The re-defined proposition was set out as follows,

‘The process of selecting building project price forecasting models was an iterative process that was affected by factors that can be categorised as being related to the project forecaster becoming aware of the project, evaluating the response required, and assessing the resources available, within the overarching constraints of organisational size and type’

In order to confirm the categories of model selection factors, their respective sub-categories and their properties it was necessary to collect more data from the field. The first step in that process was the determination of a purposeful sample of practitioners from whom data could be collected.

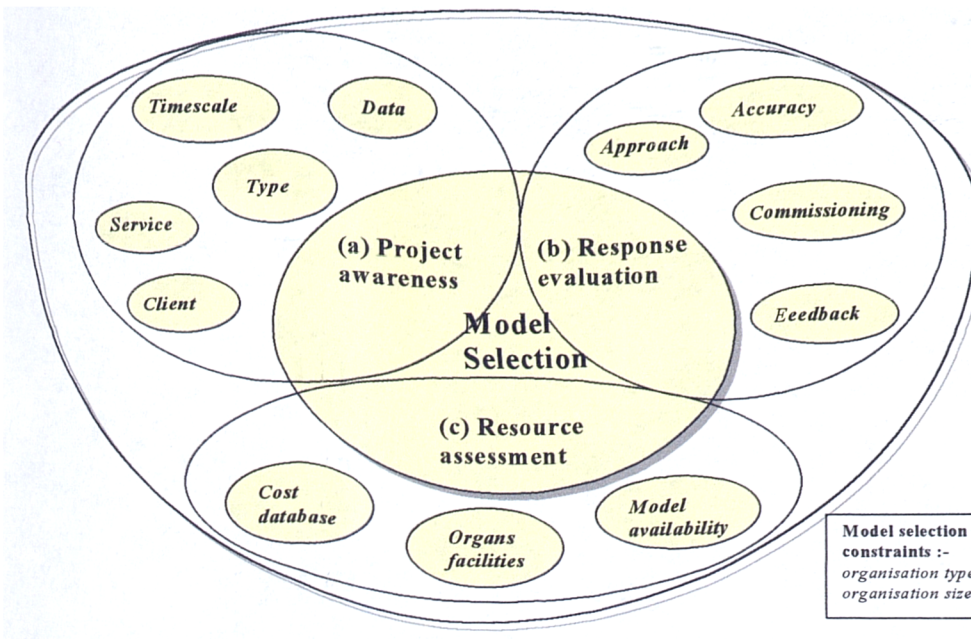


Fig. 7.5 Propositional model (2) and grounded data-analysis-framework

7.3.3 Selection rationale for interviewee's 10 - 14

The third round of interviews (10-14) were conducted in the autumn of 1997.

Table 6.2 indicated the general selection rationale from which interviewees were selected. The rationale for the selection of interviewees for the third round of data collection was guided by the practitioners selected as interviewees 1-9. For instance no data had been collected from building project price forecasters situated in large sized quantity surveying practices. Therefore an interviewee from that organisational setting needed to be included in this round of data collection. Similarly, the analysis of the data reported earlier in the chapter indicated that there were significant inconsistencies in the approaches adopted by interviewees 5 and 7 and so further data needed to be collected from interviewees who were situated in similar organisational settings in order to facilitate a cross case comparison of data.

Therefore Table 6.2 was consulted in the light of the circumstances outlined above. The following confirmed participants, who had each previously indicated that they had practical experience in at least three of the newer types of available computerised price forecasting models were contacted and agreed to become interviewees 10 -14.

Respondent 2346 was contacted and agreed to become interviewee 10 as he was a building project price forecaster who was situated in a similar organisational setting as interviewee 7. Respondent 1177 was a building project price forecaster who was situated in an organisational setting that was similar to interviewee 5. He was contacted and agreed to become interviewee 11.

Table 6.2 indicated that four of the confirmed participants in the study were situated in large sized quantity surveying practices. Each of the four confirmed participants had practical experience in at least three of the newer type of building project price forecasting models that were available. Each were contacted and respondent 292 agreed to become interviewee 12.














A further interviewee needed to be selected in order to provide further corroborating data from the building project price forecasters who were situated in large sized project management or multi-disciplinary type organisations. Each of the appropriate confirmed participants were contacted and eventually respondent 1504 agreed to become interviewee 13.

The data obtained from interviewee 9 had provided evidence of inconsistencies in approach and so it was resolved to seek more data from a building project price forecaster who was situated in a similar organisational setting. Table 6.2 was consulted and eventually respondent 972 agreed to become interviewee 14.

This round of meetings (interviews 10-14) adopted a more structured agenda of topics for discussion that reflected the emerging categories and sub-categories of model selection factors that had been incorporated into propositional model (2). The full transcripts of the taped conversations can be viewed on the disc supplied with the document

Table 7.1 provides a summary of the type and size of organisations within which interviewees 1-14 were situated.

Table 7.1 Interviewees 1 - 14 organisation size and type classifications

Type	Quantity	Surveying	Practices	Multi-	& Project	Mngment
Size	1-5	6-10	11+	1-5	6-10	11+
Interviewee 1						
Interviewee 2						
Interviewee 3						
Interviewee 4						
Interviewee 5						
Interviewee 6						
Interviewee 7						
Interviewee 8						
Interviewee 9						
Interviewee 10						
Interviewee 11						
Interviewee 12						
Interviewee 13						
Interviewee 14						

The data collected from interviewees 10 - 14 were entered into the NUD*IST4 data analysis software package and were analysed to,

- (i) *confirm the appropriateness of the main categories of model selection factors their sub-categories and their emerging properties,*
- and
- (ii) *discover the presence or otherwise of relationships between sets of criteria related to the model selection process within organisations of differing types and sizes.*

The full results of the analysis together with samples of the index tree lists and tree display diagrams that were used with the analysis of the data collected from interviewees 10 - 14 have been presented in appendix 4.

Readers note - only data that justified changes to categories of model selection factors, their sub-categories, and related properties in terms of their continued inclusion, content or labelling have been considered below. The majority of the data collected and analysed from interviewees 10 - 14 which were confirmatory in nature have not been presented here.

The diagrams included at the start of each section of data analysis reflect the emerging sub-categories and their properties which were

included as nodes in the NUD*IST4 software data analysis package.

The results of analysis (i) the confirmation of the main categories model selection factors, their sub-categories, and related properties is presented below.

7.3.4 Category (a) - Project Awareness

Fig. 7.6 illustrates the sub-categories and their existing partly grounded properties which together constituted model selection category (a) - project awareness in the revised data-analysis-framework that was used in connection with proposition (2). The amount of data assigned to each of the sub-categories listed below confirmed their retention as sub-categories within the grounded data-analysis-framework associated with proposition (3). The confirmed sub-categories were, **data**, **timescale**, **type**, and **client**

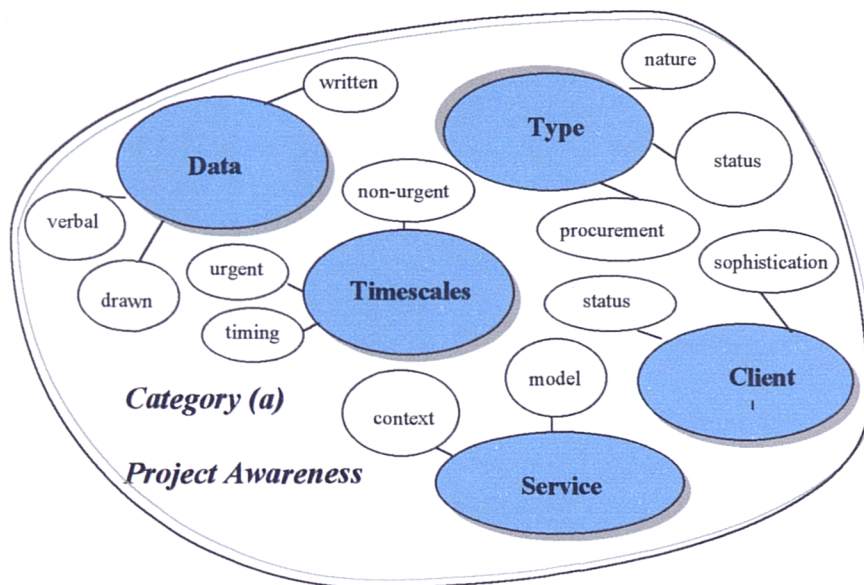


Fig. 7.6 Category (a) - Project Awareness in propositional model (2)

The data were further sifted within the NUD*IST4 software package to either confirm the appropriateness of the partly grounded properties that had been attached to each of the sub-categories illustrated in Fig. 7.6 or to detect the emergence of new properties that needed to be incorporated into a revised grounded data-analysis-framework. Each

of the sub-categories that needed to be re-aligned in terms of its properties have now been considered below.

Data

The partly grounded properties related to this sub-category were, written, drawn and verbal types of data. Earlier rounds of data analysis had indicated that the differing forms of project data had caused forecasters based in different organisational settings to select different types of building project price models. For instance in a situation in which there was only verbal project information available then forecasters commented that they either '*work something out in their head*' (int 10 tu 38) or '*following on from these basic discussions with a client we could then apply our in-house causal cost models*' (int 12 tu 141) or '*we would use a square metre rate based on the assessment of the anticipated quality levels of the client.... I would then test this initial ball park figure by using the ELSIE expert system ... which would provide some reliability to the initial cost advice figures produced.*' (int 13 tu 23-25). Once the level of project data had increased then there seemed to be agreement that the building price forecasting models selected for use would change. Typical comments that were related to this situation were those from interviewee 13 who said, '*once drawn information had become available then we would use a combination of approximate quantities and elemental analysis*', (int 13 tu 75).

Given the context of the comments in relation to the impact of differing types of project data on the selection of building project price forecasting models it was decided to refine the partly grounded properties attached to this sub-category. Accordingly it was decided to use **drawn** and **non-drawn** as the grounded properties of this sub-category in the developing grounded data-analysis-framework.

Timescale

The partly grounded properties attached to this sub-category were labelled as being urgent and non-urgent. In addition a further provisional property of 'timing' was included in the developing grounded data analysis framework. The analysed data from interviewees 10-14 provided no support for the provisional property of timing and so it was omitted. The properties of this sub-category that were retained were **urgent** and **non-urgent**.

Type

The partly grounded properties attached to this sub-category were labelled as being nature and status. In addition a further provisional property of procurement was included in the data-analysis-framework. The data analysed in connection with the property labelled nature indicated that its coding label needed to be re-considered in order to reflect the broad range of issues that the interviewees understood to be appropriate to this property. For instance interviewee 11 responded to a question on the effects of differing types of project by responding in terms of the proposed project's physical characteristics, such as his comment '*a 50,000 thousand square feet industrial unit*, (int 11 tu 460). Other interviewees commented on the nature of the project in terms of it being a repeat or it being a one-off, such as, *many of our schemes are similar in nature.... and this affects the use of computerised causal cost models*' (int 10 tu 51), and another interviewee who saw project type as being related to the following, '*more instant responses are required for commercial schemes*' (int 10 tu 48). Interviewee 13 saw the nature of a project in terms of its size and design features, for instance he commented '*the size of the project is not as important as whether the proposed scheme matches a past scheme in terms of its principal features*' (int 13 tu 147).

Given the lack of consensus in the data analysed at this coding label it was resolved to re-label it at a higher conceptual level that would allow all of the aspects indicated above to be included. Therefore it was decided to re-label project nature as **project**

features and include it as a property of the sub-category entitled project type within the developing grounded data-analysis-framework.

The data analysed at the provisional coding label of procurement produced conclusive evidence that this was not a factor that caused practitioners to change building project price forecasting models. The following were typical comments, *'no I would not say it (change in procurement type) has caused a change in the way in which we prepare early cost advice'* (int 10 tu 260) and, *'yes the pattern of procurement has changed over the last few years but I do not see that it has changed the way in which early cost advice is prepared'* (int 11 tu 606) and, *'no I would say that it has not affected the way in which we prepare early cost advice'*, (int 13 tu 157) . Given such results it was decided to omit procurement type as a property of the project type sub-category in the emerging grounded data-analysis-framework.

Client Type and Service

The partly grounded properties attached to the sub-categories of client type and service were status, sophistication, model, and context. The data analysed in connection with both of these sub-categories indicated that the interviewees were unable to draw clear distinctions between the two sub-categories. For instance, in terms of client type and sophistication the following comments were typical, *'I would say who you are working for does not affect the way in which you would compile your forecasts'* (int 11 tu 486). and *'I have not worked on a single project where a client asked for a life cycle costing exercise to be undertaken since I graduated in 1985'* (int 11 tu 479).

In terms of model demand the following comments were typical *'certain types of client, such as commercial developers are keen to see a risk analysis service provided by us while other more educated clients such as government departments are keen to see life cycle costs as part of the service that they require'* (int 14 tu 146). Following reflection on the context of the above comments it was decided to merge the two sub-categories of client type and service demand into one merged sub-category labelled **client**. It was also decided to combine the properties presently allocated between

service demand and client type so that they better reflected the broad scope of material that could be assigned to them. Accordingly it was decided to label the properties of the newly merged sub-category as **awareness, model, and context**.

7.3.5 Category (b) Response evaluation

Fig. 7.7 illustrates the sub-categories and their existing partly grounded properties which together constituted model selection category (b) - response evaluation in the revised data-analysis-framework that was used in connection with proposition (2). The amount of data assigned to each of the sub-categories listed below confirmed their retention as sub-categories within the grounded data-analysis-framework associated with proposition (3). The confirmed sub-categories were, **approach**, and **commission**

The data were further sifted within the NUD*IST4 software package to either confirm the appropriateness of the partly grounded properties that had been applied to each of the sub-categories illustrated in Fig. 7.7 or to detect the emergence of new properties that needed to be incorporated into a revised grounded data-analysis-framework. Each of the sub-categories that needed to be re-aligned in terms of its properties have now been considered below,

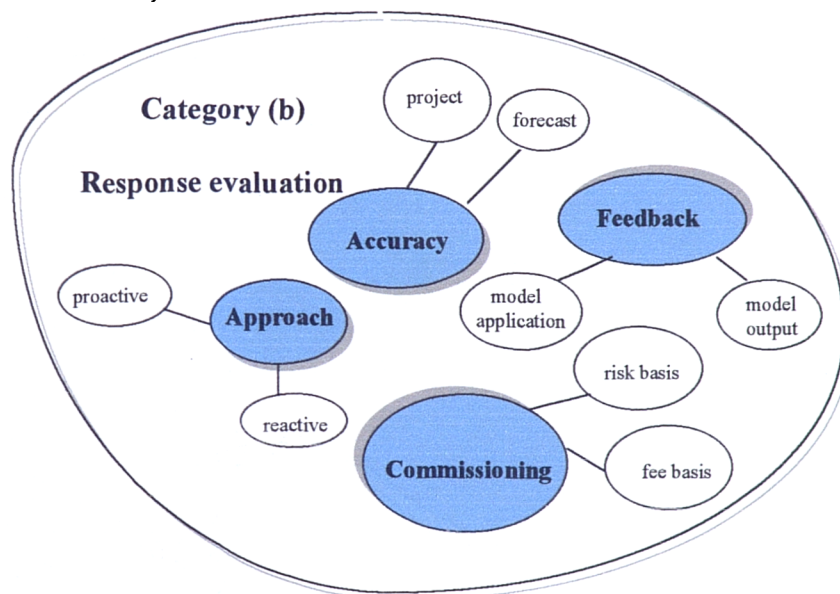


Fig. 7.7 Category (b) - Response Evaluation in propositional model (2)

Accuracy and Feedback

The partly grounded properties attached to the sub-categories of accuracy and feedback were project and forecast parameters, model output, and application. The data analysed in connection with both of these sub-categories indicated that the interviewees were unable to draw clear distinctions between the two sub-categories. Typical of the comments related to accuracy of output were, *'it is very difficult to generalise..... clients want you to be accurate all the time... we would hope to be within +/- 10%'* (int 12 tu 266-269) and *'when there is a high degree of accuracy required then I am less willing to use ELSIE - I would far rather use our own systems now'* (int 14 tu 292).

Typical of the comments made in connection with feedback included, *'well I suppose an invitation to see how it would work and then a trial period with it in action would help'* (int 10 tu 205) and *'we very rarely use the unit method as we have found it to be very broad brush'* (int 10 tu 185) and *'there is a limitation within ELSIE that prevents it modelling the specific footprint of the building we have found that the structure of ELSIE is not very flexible'* (int 13 tu 29-31)

The context of the comments indicated above have demonstrated that the model selection sub-categories of feedback and accuracy are inter-linked when looked at from the perspective of the practitioners on the ground. Kolb (1984) maintained that professionals learn by constantly seeking and reflecting on feedback. The capability of a practitioner to achieve acceptable levels of model output must involve the evaluation of feedback from the forecast receiver in terms of the usefulness of the forecast received. The practitioners interviewed were unable to clearly distinguish between accuracy and feedback. Given the grounded nature of this approach it was decided to merge the sub-categories of accuracy and feedback together and label the merged sub-category **accuracy**. In view of the above discussion it was also resolved to include **feedback** in terms of **output** and model **application** amongst the properties attached to the newly merged sub-category.

7.3.6 Category (c) Resource Assessment

Fig. 7.8 illustrates the sub-categories and their existing partly grounded properties which together constituted model selection category (c) - resource assessment in the revised data-analysis-framework that was used in connection with proposition (2). The amount of data assigned to each of the sub-categories listed below confirmed their retention as sub-categories within the grounded data-analysis-framework associated with proposition (3). The confirmed sub-categories were, **cost database**, **support facilities**, and **culture**

The data assigned to each of the confirmed sub-categories listed above also confirmed the appropriateness of the partly grounded properties that had been previously applied to each of the sub-categories illustrated in Fig. 7.8. Therefore it was decided to retain each of the properties shown in Fig. 7.8 within the grounded data-analysis-framework associated with propositional model (3)

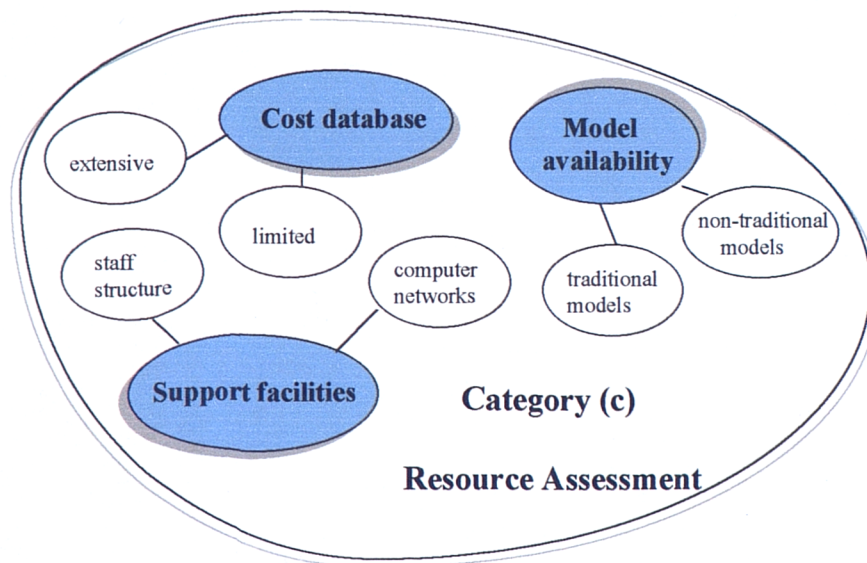


Fig. 7.8 Category (c) Resource Assessment in propositional model (2)

7.3.7 Summary

The extent and quality of the analysed data collected from interviewees 10-14 fully grounded the main categories of factors affecting the building project price forecasting

selection process. The analysed data also provided evidence of grounding amongst the emergent and partly emergent sub-categories of factors implicitly identified within proposition (2)

The emergent and partly emergent sub-categories within category (a) - **project awareness** included data, type, timescales, client, and service. Following analysis of the data collected from interviewees 10-14 the following sub-categories emerged as being grounded, namely, **data**, **timescale**, and **type**. A further newly enlarged sub-category of **client** was identified through the merger of data previously coded at service demand and client.

The emergent and partly emergent sub-categories within category (b) - **response evaluation** included, approach, accuracy, feedback, and commissioning. Following analysis of the data collected from interviewees 10-14 the following sub-categories emerged as being grounded, namely, **approach** and **commission**. A further newly enlarged sub-category of **accuracy** was identified through the merger of data previously coded at accuracy and feedback.

The emergent and partly emergent sub-categories within category (c) - **resource assessment** included cost database, support facilities and model availability. Following analysis of the data collected from interviewees 1-14 the following sub-categories emerged as being grounded, namely, **cost database**, **support facilities**, and **culture**. The grounding of the newly emergent enlarged sub-categories of client and accuracy called for further data analysis.

7.4 Cross-case data analysis and propositional model (3)

7.4.1 Emergent data analysis

The newly enlarged and emergent sub-categories of client and accuracy needed to be grounded in the experiences of practitioners involved in the building project price forecasting model selection process. Data had been gathered from interviewees 1- 14

and so it was decided to use the merge and search facilities within the NUD*IST4 software package. The results of the search in respect of the two outstanding sub-categories of factors affecting the selection of building project price forecasting models has been presented below.

Client

This sub-category was enlarged through the merger of client demand and service. The data from interviewees 1 - 14 were used to check that this newly emergent sub-category could be considered as grounded. Typical of the comments from interviewees who saw client influence as a factor that affected the model selection process were, *'I suppose the main driver for the selection (of models) is still the approach and the demands of the client'* (int 8 tu 246) and, *'a real criteria that influences the use of the newer techniques must be client demand'* (int 5 tu 105) and *'certain clients such as the MOD or Home office require a full risk analysis service on their projects'* (int 2 tu 262). However, interviewees 1, 6, and 7 said that the impact of client type and demand on the models they would select for use, would be negligible. For instance interviewee 1 commented *'as far as I am concerned I would say that the client type would not influence the choice of technique to use in any way at all'* (int 10 tu 639). The emergent data analysis indicated above clearly indicates that client is a factor that caused differing building project price forecasters to select differing models for use. This evidence grounds **client** as a further emergent sub-category that needed to be included in the grounded data-analysis- framework.

Accuracy

This sub-category was enlarged through the merger of accuracy and feedback. The data generated from interviewees 1 - 14 were used to check that this newly emergent sub-category could be considered as grounded. Interviewees 1, 3, and 6 all acknowledged that accuracy of model output was the main factor that affected the building project price forecasting model selected for use. Typical of the comments made were *'accuracy is the main factor that determines the choice between models'* (int 3 tu 459) and *'if we are not accurate then our necks will be on the line'* (int 3 tu 465). Other

interviewees (4, 5, and 8) said that although accuracy was important it was not the main factor that affected the selection of models for use. Typical of the those comments made were, '*I think accuracy and time are very important*' (int 8 tu 404). Interviewee 3 and 4 saw accuracy in terms of feedback on the models that they used, typical comments were, '*we have used the ELSIE system and found it to be unsatisfactory*' (int 4 tu 565).


































The emergent data analysis indicated above clearly indicates that accuracy is a factor that caused differing building project price forecasters to select differing models for use. This evidence grounds **accuracy** in its broader definition as a further emergent sub-category that needed to be included in the grounded data-analysis-framework. A consequence of the data analysis undertaken in connection with the above was the appearance of patterns or clustering of factors that affected certain building project price forecasters in certain situations. As a result it was decided to re-examine the data generated from interviews 1 -14 in order to ascertain whether distinct patterns or clusters of factors could be determined amongst the interviewees responses

7.4.2 Cross-case data analysis - interviewees 1 -14

It was decided to conduct a rudimentary cross-case search of the data collected from interviewees 1 - 14 in order to examine whether there were any patterns or clustering of data gathered from interviewees situated in differing organisational settings in terms of the type of building project price forecasting model being selected for use. The NUD*IST4 software package facilitated such a search by being able to look for the intersections of specified categories within its index-tree system.

Table 7.2 provides a summary of the results. The traditional models were selected for use by all interviewees. However, it was observed that interviewees who were selecting the newer non-traditional based techniques were clustered in the larger sized multi-disciplinary and project management types of organisations whereas the interviewees who were situated in the smaller sized quantity surveying practices did not. This result broadly mirrored the findings of the statistical analysis of the data collected from the nation-wide survey which was discussed in chapter 4.

Table 7.2 Clustering of interviewees (1 -14) and model selection

Non - Traditional Types of Models						
Interviewees	Causal Cost Models	Life Cycle Models	Expert Systems	Risk Analysis	Value Related	Resource Based Models
QSP small						
1						
3						
6						
NQSP small						
7						
10						
QSP Large						
9						
12						
14						
NQSP Large						
2						
4						
5						
8						
11						
13						

QSP Quantity surveying practices
NQSP Non-quantity surveying organisations (project management and multi-disciplinary type organisations)

The findings of the cross-case search indicated a pattern of use that needed further investigation. If the findings were replicated in further data collected from practitioners involved in the model selection process then the factors that have been identified as affecting building project price forecasters in their selection of models for use needed to be put into an organisational context. In order to help shape the further collection of data it was decided to form a further proposition.

7.4.3 Propositional model (3) and an emerging constraints-based theory

As a result of the data analysed from interviewees 10-14 the three main model selection categories of (a) project awareness, (b) response evaluation, and (c) resource assessment together with their sub-categories have now been confirmed as grounded. The results of an initial rudimentary cross-case search indicated that the way in which a price forecaster used the selection factors were constrained by the forecaster's organisational setting. A further constraint on the price forecaster's selection of a forecasting model for use was identified as a result of the quantitative study reported in chapter 4.

The statistical analysis of the data collected from the nation-wide survey on building project price forecasting models in-use revealed that the forecasters own level of model understanding was a factor that affected model selection. Lack of model understanding did not raise itself as a model selection factor in the data gathered and analysed from interviewees 1-14. This omission was not unexpected given the nature and purpose of this more qualitatively based phase of the study. The interviewees were drawn from those confirmed participants for whom lack of model understanding was not a constraint.

The grounded model selection factors, and the potential relationship between them and the constraints on their usage, in terms of the forecaster's organisational setting and lack of model understanding, have been illustrated as a propositional model (3) in Fig. 7.9. Propositional model (3) was set at a high level of abstraction in order to reflect the extent of its grounding in the experiences of practitioners in the field. Fig. 7.9 illustrates that the positive model selection categories and their associated sub-categories, were constrained by the negative factors of the forecaster's organisational setting in terms of size and setting and the forecaster's own level of model understanding.

The relationship between the negative constraints and the positive model selection categories have now been tentatively described as an emerging constraints-based

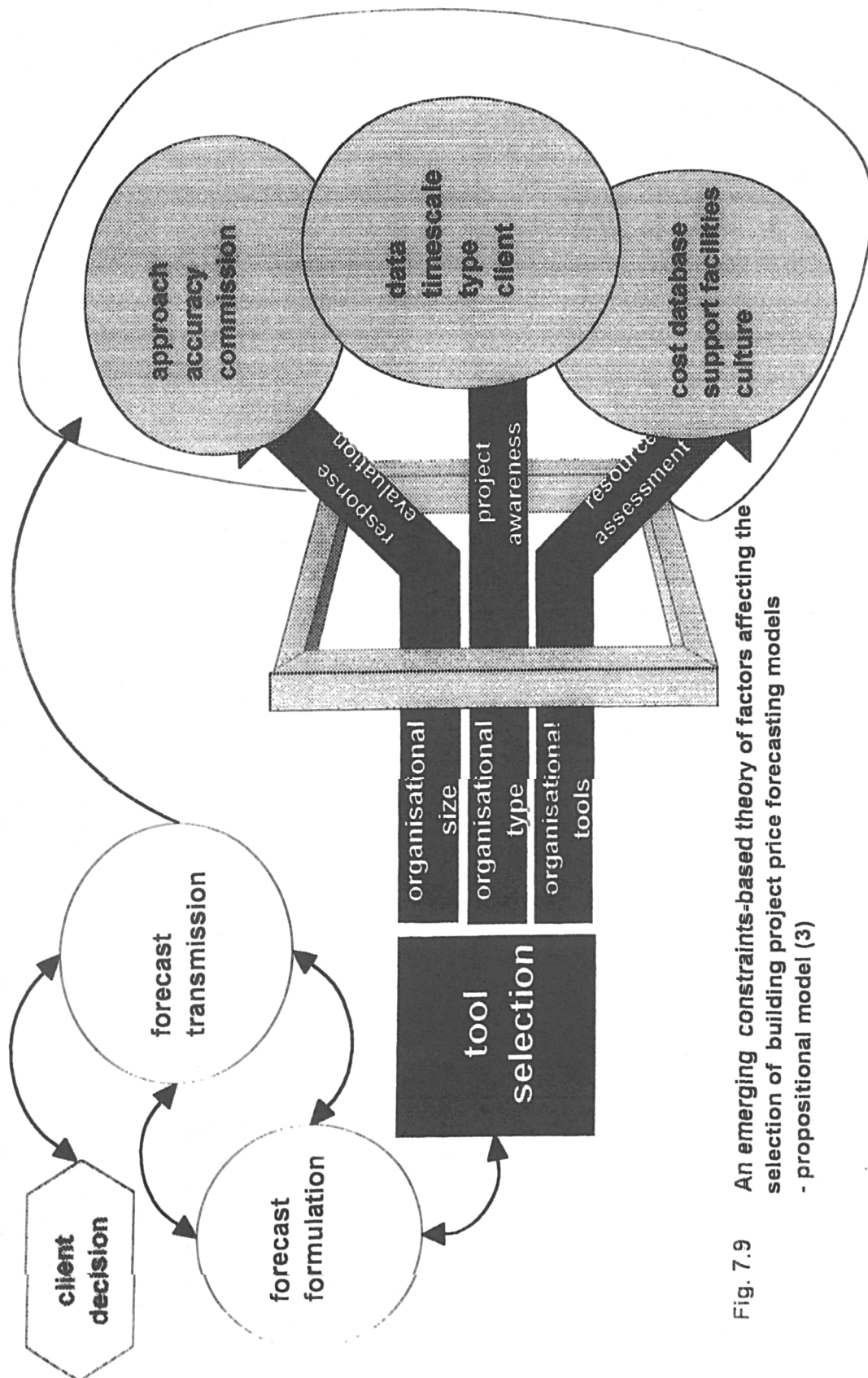


Fig. 7.9 An emerging constraints-based theory of factors affecting the selection of building project price forecasting models - propositional model (3)

theory of factors affecting the selection of building project price forecasting models. Proposition (3) was developed in order to shape, focus, and bound the collection and analysis of further data and it was expressed in the following terms,

'The process of selecting building project price forecasting models was an iterative process that was affected by the interrelationship of factors such as project data, project timescale, project type, and project client (project awareness), and factors of response approach, response accuracy, and response commission (response evaluation) together with factors of cost database assessment, availability of support facilities, and prevailing culture (resource assessment) within the overarching constraints of the forecaster's situation in either small or large sized quantity surveying only or project management and multi-disciplinary types of organisations and the forecaster's own level of model understanding'

The steps taken to further ground proposition (3) and consequently the emerging constraints-based theory of factors affecting the selection of building project price forecasting models have been reported in the next chapter.

7.5 Summary and reflections on the research process

7.5.1 Summary and implications for future work

This chapter reported the continuing exploration of the territory associated with the factors affecting the building project price forecasting model selection process. The explorations were conducted in two phases. Firstly, further exploratory data were collected from interviewees 5-9, and then secondly, a round of more confirmatory data were collected from interviewees 10-14.

Data analysed from interviewees 5 - 9 explored the relationships between the conflicting factors that were expressed in proposition (1). Proposition (1) advanced a conceptual theory that the factors affecting building project price forecasting model selection could be categorised as being related to project awareness, data evaluation, resource assessment, and tool applicability. In the process of exploring propositional model (1) a number of sub-categories and their properties were grounded in the experiences of practitioners involved in the selection of building project price forecasting models. Other sub-categories emerged from the data and were identified as being provisional or partly grounded in their nature. On completion of the analysis the

four main categories of model selection factors were reduced to three, namely, project awareness, response evaluation, and resource assessment.

The emergent categories of model selection factors were incorporated in proposition (2) and illustrated as propositional model (2) in Fig. 7.5.

Proposition (2) was explored following the collection and analysis of data from interviewees 10-14. The analysed data grounded the main categories of model selection factors as being, namely, project awareness, response evaluation, and resource assessment. In addition the following sub-categories of model selection factors were also grounded, namely, approach, accuracy, commission, (project awareness), data, timescale, type, client, (response evaluation), and cost database, support facilities, and culture, (resource assessment).

On completion of the analysis, the data were re-examined in a rudimentary cross-case analysis which provided evidence of clustering of the categories and sub-categories of selection factors. The clustering was evidenced in the propensity of non-traditional building project price forecasting models to be selected by forecasters situated in certain types and sizes of organisation. In particular there was evidence that the most marked differences in the types of models selected for use occurred when the building project price forecasters were situated in either small sized or larger sized organisations. A further constraint on the use of the categories and sub-categories of model selection factors was the forecaster's own level of model understanding. This had been identified as a negative model selection factor in the quantitatively based work reported in chapter 4. Accordingly a tentative set of relationships were developed which were termed as an emerging constraints-based theory of the factors affecting the selection of building project price forecasting models. The emerging constraints-based theory was illustrated as propositional model (3) in Fig. 7.9.

The emerging categories and sub-categories of factors affecting the selection of building project price forecasting models together with the overarching constraints of organisational type, size, and level of model understanding were then incorporated into

proposition (3). The formulation of proposition (3) enabled further data to be gathered, which when analysed, would further ground the emerging constraints-based theory of factors affecting the selection of building project price forecasting models.

7.5.2 Implications for future work

The steps needed to more firmly ground the emerging theory that was detailed in proposition (3) above, needed to involve the purposeful selection of informed participants who were situated in organisations of differing types and sizes. Given the scope of this study and the nature of its participants it was decided that lack of model understanding, as one of the overarching negative constraints that affected the categories and sub-categories of model selection factors could not be investigated any further. The impact of this constraint needed to be assessed by subsequent studies in the field.

The analysis of data collected from further informed interviewees gathered in the context of their organisational setting would permit the more positive categories of factors affecting model selection and the emerging constraints-based theory to become more firmly grounded in the experiences of practitioners involved in the model selection process.

7.5.3 Reflections on the research process undertaken

The challenges experienced in this part of the research process involved mastering the qualitative data analysis software package and the fine tuning of skills in written communications.

The learning curve involved in mastering the NUD*IST4 software data analysis package was particularly steep. There was a lack of peer support that was experienced in the use of the package. The feeling of becoming detached from the completeness of the interview transcripts was one that necessitated continual backtracking to contextualise the data. Nevertheless the advantages of using the data analysis package in terms of speed and thoroughness when searching for patterns and combinations of data sets outweighed the efforts involved in coming to terms with its unfamiliarity.

The challenge of writing an informative, detailed account of the qualitative research activities undertaken in this section of the study was a task that the researcher found to be particularly difficult. The balance between providing too much detail and too little detail, as well as the challenge of presenting the emerging ideas and concepts from the inductive analysis of the data was not achieved without considerable effort. The production of drafts of texts and diagrams for discussion, alteration re-writing and re-drafting was a process that could not be short circuited. The volume of discarded analysis, computer print outs, and re-drafted sections of material was awesome.

Balanced against the iterative processes indicated above was the positive feelings associated with finding out new knowledge. The process of identifying and grounding real factors that affected the real issue of building project price forecasting model selection, as seen through the eyes of the practitioners involved, provided a real sense of personal satisfaction.

7.6 References

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Chapter 8

An emerging grounded theory of the factors affecting the selection of non-traditional types of building project price forecasting tools

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Chapter 8

An emerging grounded theory of the factors affecting the selection of non-traditional types of building project price forecasting tools

8.1 Introduction

8.1.1 Generally

Chapter 7 detailed the grounding process which enabled the individual factors that were found to affect the selection of building project price forecasting models to be grouped into a number of sub-categories within the three main conceptual categories of project awareness, response evaluation, and resource assessment. The grounding of the three conceptual categories and their sub-categories was achieved following the collection and analysis of data gathered from interviewees 1-14. As a result of the grounding process a pattern was observed which suggested that the organisational setting of the building project price forecaster had an affect on the types of building project price forecasting models selected for use. The detection of this pattern together with the quantitatively based evidence reported in chapter 4 facilitated the emergence of a tentative constraints-based theory of factors affecting the selection of building project price forecasting models.

This chapter provides an account of the steps taken to further ground the emerging theory in the experiences of more practitioners situated in organisations of differing types and sizes. It provides a rationale for the purposeful selection of interviewees 15-21 and 22-31 and details the analysis undertaken to examine the emerging theory through the eyes of practitioners situated in the organisational settings indicated above. The chapter concludes by advancing an emergent constraints-based theory of factors that affect the selection of building project price forecasting models in both small sized quantity surveying practices and larger sized project management or multi-disciplinary types of quantity surveying organisations.

In order to allow this grounding process to happen it was necessary to locate practitioners that were situated in quantity surveying organisations of differing sizes and types and who had previously indicated that they were familiar with the selection of non-traditional building project price forecasting models

8.1.2 Selection rationale for interviewees 15-21

The fourth round of interviews (15-21) were conducted in the spring of 1998.

Table 6.2 indicated the general rationale from which the interviewees were selected. The rationale for the selection of the interviewees for the fourth round of data collection was guided by the data collected from interviewees 1-14. The analysis of that generated data, and the results of the rudimentary cross-case analysis (see chapter 7, section 7.4.2), together with the results of the quantitatively based investigation undertaken in phase one of the study, indicated that building project price forecasters who were situated in larger sized organisations were more likely to be involved in the selection of newer types of non-traditional building project price forecasting models, than building project price forecasters who were situated in other types of organisations. Therefore the practitioners selected as interviewees 15-21 were as follows,

Interviewees 17, 19, and 20 (respondents 572, 1714, and 1101)

These interviewees were situated in organisations which had been styled as quantity surveying types of practices on the participant confirmation forms. All the interviewees that were selected were situated in organisations that were large in size i.e. more than eleven members of staff engaged in the selection of building project price forecasting models. The interviewees were situated in practices that had one, or more than one office within its organisation.

Interviewees 15, 16, 18, and 21 (respondents 1183, 592, 1458, 1723)

These interviewees were situated in organisations which they had described as multi-disciplinary or project management types of practices. The participant confirmation

forms had indicated that they were large in size i.e. more than eleven members of staff engaged in the selection of building project price forecasting models. The interviewees were situated in practices that had more than one office within its organisation. During the conversation with interviewee 15 it was found that interviewee 15's organisation was not a multi-disciplinary type of organisation that employed more than eleven building project price forecasters. As such, interviewee 15 did not match the organisational type from which the current round of interviewees had been selected. Nonetheless it was decided to gather data from interviewee 15 in order to facilitate a preliminary cross-case comparison.

This round of meetings (interviews 15 -21) adopted a structured agenda of topics for discussion that reflected the emergent categories and sub-categories of factors found to affect the selection of building project price forecasting models and which had been incorporated into propositional model (3). The taped conversations of interviews 15-21 lasted on average fifty minutes. The full transcripts of the taped conversations have been provided as document files stored on the disc supplied with the document.

The data collected from interviewees 15-21 were entered into the NUD*IST4 data analysis software package and analysed to,

- (i) *Further ground the clustered groups of categories and sub-categories of factors affecting the selection of building project price forecasting models*
- (ii) *Determine whether there were any patterns between the building project price forecasting models selected for use and the clustered categories and sub-categories of factors found to affect the selection of non-traditional types of building project price forecasting models.*

Such an analysis of the data gathered from interviewees 15-21 provided evidence of the further grounding of the selection factors embodied in proposition (3).

8.2 Propositional model (3) & emergent data analysis

8.2.1 Generally

Proposition (3) identified the grounded categories and sub categories of factors that were found to affect the selection of non-traditional types of building project price

models and postulated that differing clusters of factors would result in differing models being selected. Proposition (3) also postulated that there would be differences in the types of non-traditional models selected for use by the building project price forecasters who were situated in organisations of differing types and sizes. A further constraint on the selection of building project price forecasting models, namely, the level of model understanding achieved by the forecaster, was not considered as part of this study due to the limited nature of its resources.

Accordingly an index tree was constructed within the NUD*IST4 software analysis package that enabled the forecasters organisational setting, the forecasting models selected for use, and the sub-categories listed in proposition (3) to be analysed for evidence of emerging patterns. A copy of the index tree and tree display diagram used within the package can be seen in appendix 4. The data generated within the package were then searched at index tree level to identify sub-category intersections. The intersections found were then considered for evidence of emerging patterns or clusters of factors that enabled the emerging constraints-based theory of factors found to affect the selection of non-traditional types of building project price forecasting models to become more firmly grounded.

The results of that data analysis have now been considered in connection with each of the grounded main categories of selection factors, namely project awareness, response evaluation, and resource assessment. A within-case analysis of each of the main categories of factors found to affect the selection of the non-traditional types of models was undertaken in order to identify any patterns present within the analysed data. The data were gathered from practitioners situated in large multi-disciplinary or project management type organisations to form a 'case' which was labelled as (NQSP) i.e. interviewees 16, 18, and 21. Similarly the data gathered from practitioners situated in large quantity surveying type practices were grouped to form a case which was labelled as (QSP) i.e. interviewees 17, 19, and 20. In addition data from interviewee 15 were also considered in order to conduct a preliminary cross-case data analysis.

8.2.2 Project awareness

The sub-categories of factors that had been found to affect model selection within the project awareness category included, (a) project data, (b) timescale, (c) project type, and (d) client. Each were considered to ascertain the existence of any within-case patterns of influential factors and the selection of the non-traditional types of models.

(a) Project data

Data collected from interviewees 1-14 indicated that practitioners based in organisations that were prepared to provide building project price forecasting advice irrespective of the existence of any drawn design / project information were more likely to select the non-traditional types of price forecasting models than were practitioners who were situated in other types of organisations who were constrained in terms of model selection by the need to wait until drawn project information became available.

Interviewees 17 and 19 (QSP) differed in their approach from the practitioners situated in the other large sized organisations. The approach adopted by the majority of the interviewees analysed within this case was indicated by comments such as,

'in our definition of early cost advice we would look to become involved before any other consultants were involved ... this would entail us providing early cost advice before there were any drawings available for the project'

(int 21 tu 33-38)

and *'it may well be that your initial estimate is provided without any design information being available'* (int 18 tu 356). These comments can be contrasted with the more cautious approach indicated in the comments of interviewees 17 and 19 (QSP) who said *'at this stage we would need sketch scheme drawings'* (int 19 tu 34) and *'it would be usual to have some drawn information available upon which to base some initial advice'* (int 17 tu 37) .

(b) Timescale

The main issue that differentiated between the (QSP) and (NQSP) types of organisation in respect of this sub-category was whether it was a type of organisation that was always having to respond within a mainly urgent timescale to requests for

building project price advice or whether it also responded to requests for building project price advice in what were non-urgent timescales. Data previously collected and analysed from interviewees 1-14 had indicated that the non-traditional types of building project price forecasting models required a non-urgent timescale to be available in order for them to be selected. Therefore it was felt that the organisational type that had urgent and non-urgent timescales available to it for response would be more likely to select the non-traditional types of building project price forecasting models for use.

Interviewees 18 and 21 (NQSP) indicated that lack of time was not a major factor, typical comments were *'well there is never enough time but I don't think that timescale is a major factor'* (int 18 tu 634). Other interviewees thought that lack of time was a major issue which affected their selection of particular types of models, for instance, *'the lack of time may influence the use of expert systems'* (int 16 tu 160), and *'in my view the amount of time available for a response has a greater impact than the availability of project information it actually takes longer to produce an estimate with a computer than it does by using traditional techniques'* (int 15 tu 130)

(c) Project type

The main issue that differentiated between the (QSP) and (NQSP) organisations in terms of this sub-category was whether an organisation was involved in forecasting the likely prices of common or repeat projects or whether it also had to forecast the likely price of a number of 'one-off' or prestige building projects as well. Previous data collected and analysed from interviewees 1-14 had shown that organisations which had to forecast likely building project prices for usual as well as non-usual types of projects were more likely to select the newer non-traditional types of building project price forecasting models.

Interviewee 15 was a building project price forecaster who was situated in a small sized quantity surveying practice who indicated that their project types were often of a repeat nature when he said, *'the choice of whether to use a cost model comes down to the surveyor making a judgement on whether the work is likely to be used again ... if it*

was not then it would be unlikely that I would use our cost model' (int 15 tu 240). Similarly interviewee 16 (NQSP) and interviewee 17 (QSP) indicated that they did *'a lot of work for Sainsbury supermarkets and to a large extent this was repeat work'* (int 16 tu 56).

However interviewees 18 and 21 (NQSP) indicated that the type of projects that they were involved with also included projects that were of a unique nature as well as projects that were of a repeat nature. For instance, interviewee 18 commented,

'we do a lot of work for the supermarket groups and leisure centre developers, and these regular clients do tend to work to a set format ... this results in traditional models being used which is the way most of our jobs are done especially when we are providing estimates for regular projects' (int 18 tu 335-342).

Similarly interviewee 21 commented,

'for large sophisticated clients who have many repeat schemes then it would be worthwhile developing bespoke cost models, for other clients such as large commercial clients who are looking to develop a city centre scheme then that would be different, as each scheme would be different with different site constraints' (int 21 tu 310).

(d) Client

The data collected from interviewees 1-14 indicated that practitioners involved in the model selection process who were situated in organisations which had a range of large and sophisticated clients were more likely to be involved in the selection of non-traditional types of building project price forecasting models than were forecasters who were situated in organisations that were dealing with a limited range of more inexperienced clients. The data analysed from the fourth round of data collection indicated that interviewees 16, 18, 21, (NQSP), and 19 (QSP) undertook services for sophisticated or educated clients whereas the other interviewees did not.

Typical of the comments made by those interviewees who worked for sophisticated clients were, *'some of our clients ... are termed as being sophisticated in nature and as a result we are often asked to provide a risk analysis service'* (int 18 tu 406), and *'on other schemes for sophisticated clients then it may be more appropriate to consider running a value management exercise'* (int 18 tu 412). Interviewee 15 was typical of those interviewees who did not provide services for sophisticated clients and as a result the

following comments were typical, namely, *'no I have not found that clients are asking for such risk analysis services'* (int 15 tu 289)

Summary of project awareness model selection factors

The following patterns of selection factors and types of models selected for use emerged from the data analysed above, namely,

interviewees 18, 21,(NQSP) and 19 (QSP) who,
selected non-traditional types of models on projects that had drawn and non-drawn data available, and who responded in urgent and non-urgent timescales, on projects that were of a usual and non-usual type, and who worked with sophisticated and non-sophisticated clients,

and

interviewees 15 (NQSP) and 17 (QSP) who
selected non-traditional types of models on projects that had drawn project data available, and who responded in urgent timescales, on projects that were of a usual type, and who worked with non-sophisticated clients

No clear pattern emerged across the sub-categories that made up project awareness in terms of interviewees 16 and 20.

8.2.3 Response evaluation

The factors that were found to affect model selection within the response evaluation category included, (a) approach, (b) accuracy, and (c) commission. Each have now been considered to ascertain the existence of any within-case patterns of influential selection factors and non-traditional types of models selected for use.

(a) Approach

Data analysed from interviewees 1-14 indicated that building project price forecasters situated in organisations that were more proactive than reactive in their approach to the provision of building project price advice, were more likely to select the non-traditional types of model for use. Accordingly, the data from interviewees 15-21 were examined for any evidence of patterns within cases of a similar nature that would support that assertion. Interviewees 16, 18, 21 (NQSP) and 19 (QSP) were found to adopt a proactive approach to the provision of their building project price forecasting services. For instance, the following comments were typical,

'clients expect more than passive cost control they expect a positive contribution into their development process' (int 16 tu 338), and *'we are becoming*

more proactive in marketing the full range of our services which would include risk analysis, value management and so on' (int 18 tu 475), and *'we would not wait for a client to ask for a service as there are circumstances when we would be suggesting to a client that a particular scheme is subjected to a value management exercise'* (int 21 tu 354)

Interviewees 15 (NQSP), and 17 and 20 (QSP) were found to have a more reactive approach to the provision of their services. Typical comments included,

'perhaps we as consultants are sometimes guilty of not ensuring that the client does need to consider other matters' (int 15 tu 45), and *'I feel that we in this practice are a bit behind other business organisations'* (int 17 tu 227), and *'to be honest I do not know what such systems (ELSIE) are capable of and I do not need to find out as we have not been asked to do it'* (int 20 tu 217)

(b) Accuracy

Data gathered from interviewees 1-14 indicated that there was a difference in the way building project price forecasters, who were situated in organisations of differing types, approached accuracy in terms of their forecasts. Some forecasters considered accuracy solely in terms of model output in comparison to the lowest tender received whereas others considered accuracy in terms of feedback on the way in which the model was applied and the reliability of the data it generated. There was some evidence that forecasters who considered accuracy in terms of model application and reliability of output were more likely to be involved with the selection of the non-traditional types of building project price models for use.

The data indicated that interviewees 15, and 17 considered accuracy solely in terms of model output accuracy whereas interviewees 16, 18, 21, 19, and 20 all provided evidence of considering accuracy in terms of feedback on model applicability and reliability. Typical comments from those interviewees who only considered model output accuracy were,

'in terms of accuracy my pre-tender estimates are coming in within 5% of tender and so everything seems to be in order' (int 15 tu 117), and *'I believe that clients are looking for early stage cost advice that is accurate and reliable, both are terms for the same thing'* (int 17 tu 118)

In terms of the interviewees who took a wider view on accuracy in terms of the selection of their model for use then the following comments were typical, *'I frequently found myself overriding its (ELSIE) advice due my own experience with*

similar past projects' (int 19 tu 231) and *'in my opinion it is important to provide reliable advice rather than accurate early cost advice'* (int 21 tu 238).

(c) **Commission**

The data generated from interviewees 1-14 indicated that the way in which building project price forecasters were commissioned had an impact on the types of models selected for use. There was some evidence to suggest that when forecasters were situated in organisations that provided a narrow range of services following specific commissions from clients then they were less likely to select the non-traditional types of building project price forecasting models for use than were practitioners who were situated in organisations that were prepared to work on a risk as well as a fee basis for clients who wanted a broader range of services. The data generated from interviewees 15-21 indicated a division between the interviewees in terms of organisational type. The data analysed indicated that interviewees 16, 18, and 21 (NQSP) adopted a different approach to interviewees 17, 19, and 20 (QSP).

Typical of the comments from building project price forecasters who were situated in the (NQSP) type of organisations were those from interviewee 16 who said,

'I think at the end of the day we are trying to provide a value for money service that is increasingly moving away from the conventional narrow traditional focus' (int 16 tu 335), and

'we are finding that clients are asking us as an organisation to solve problems that exceeded the range of normal quantity surveying activities' (int 18 tu 321).

Typical of the views of building project price forecasters who were situated in the (QSP) type of organisations were those from interviewee 19 who said, *'we in general tend to price what is in front of us and not necessarily think through the wider implications of what could happen if things go wrong'* (int 19 tu 205), and interviewee 17 who said, *'if we were to provide this service then we would have been invited to bid for it in competition with others or have been asked to provide it'*, (int 17 tu 177)

Summary of response evaluation model selection factors

The following patterns of selection factors and non-traditional models selected for use emerged from the data analysed above, namely,

interviewees 16, 18, 21, and (NQSP) who
adopted a proactive approach to the provision of their building project price forecasting services, and who considered accuracy to be more than just feedback on the accuracy of the model output, and who accepted an extensive range of commissions,

and

interviewees 15(NQSP) and 17 and 20 (QSP) who
adopted a reactive approach to the provision of their building project price forecasting services, and who considered accuracy only in terms of comparative accuracy of model output, and who looked to receive a narrow range of commissions

There was some evidence that interviewee 19 matched the pattern of the practitioners situated within the **(NQSP)** type of organisations rather than the pattern of the practitioners situated within the **(QSP)** type of organisations.

8.2.4 Resource Assessment

The factors that have been found to affect model selection within the resource assessment category included, (a) cost database, (b) support facilities, and (c) culture. Each have now been considered to ascertain the existence of any within-case patterns of factors found to be influential in relation to the selection of non-traditional types of building project price forecasting models.

(a) Cost database

Evidence gathered from interviewees 1-14 indicated that the extent and type of cost database available to building project price forecasters had an impact upon the type of building project price forecasting models selected for use. It was found that those forecasters who had access to extensive cost databases, in which networked electronic data were stored which had been captured from the organisations multiple offices were more likely to select non-traditional types of building project price forecasting models than were those practitioners who were situated in organisations that did not have access to such extensive cost databases.

Interviewees 15, 19, and 20 indicated that they did not have access to such extensive cost databases. Typical of the comments from these interviewees were,

'if there is anything that I am unsure about then I do look in the published price books' (int 15 to 211), and

'the large cost database that is mainly stored within individuals' (int 19 tu 44), and
'we have not stored our cost data in any centralised manner we prefer to talk to the member of staff ... in order to capture the data directly' (int 20 tu 195)

Interviewees 16, 17, 18, and 21 indicated that they had access to extensive cost databases. Typical of their comments were,

'an advantage that this organisation has over other organisations is that because of its size it has at its disposal an in-house data store which can be searched electronically' (int 17 tu 152) and
'the cost database has been compiled from projects that have been completed across the organisation' (int 18 tu 385), and
'data from past projects are captured from across the country and stored electronically in order to build up our cost database' (int 21 tu 176)

(b) Support facilities

Data gathered from interviewees 1-14 indicated that practitioners who were situated in organisations which were operating on a multi-site basis and who had access to the expertise of staff located in other offices were more likely to be involved in the selection of the non-traditional types of building project price forecasting models for use. The data gathered from interviewees 15-21 indicated the following pattern, namely, interviewees 15, 16, 18, 21, and 17 had access to the support facilities indicated above whereas the other interviewees did not.

Typical of the comments from those interviewed, who had access to limited support facilities, were those from interviewee 20 who said, *'this is the sole office of the organisation ... we have now recently appointed a quantity surveyor who has skills in services installations and so we might now be in a position to undertake life-cycle cost calculations in the near future'*, (int 20 tu 30, and 295).

The advantages of having more extensive support facilities were indicated by interviewee 15 who commented,

'one of the distinct advantages of being located within a multi-disciplinary organisation is that we can obtain back up information from the building surveyors, architects, and engineers', (int 15 tu 80), and
'we have a system called pyramids which has been recently developed and is in-house at our Altrincham office', (int 16 tu 36), and
'I am not that familiar with risk analysis techniques and so if a situation arose that called for a specific type of risk analysis model then I would contact an expert within the organisation', (int 17 tu 99)

(c) **Culture**

Data captured from interviewees 1-14 indicated that practitioners who were situated in organisations that were open and forward looking or learning in their approach were more likely to be involved in the selection of non-traditional types of building project price forecasting models. There was some evidence that indicated that such a culture within an organisation was either on a personal or organisational level depending upon its size. The data analysed from interviewees 15-21 indicated that all the interviewees with the exception of interviewee 20 were located in learning organisations.

Typical comments from those interviewees who were situated in organisations that had an open, learning culture towards the selection of different types of building project price forecasting models were,

'I would say that this organisation is certainly a learning organisation when compared to other organisations that I have worked in' (int 15 tu 246), and
'this practice would be termed as a construction consultancy as the services it provides exceeds the traditional quantity surveying practice' (int 16 tu 12), and
'we are committed to in-house training ... we have partnerships with course providers for trainee quantity surveyors', (int 17 tu 245).

Interviewee 20 indicated that the culture of learning in his organisation was on a personal level rather than on an organisational level, for instance he commented, *'we have gone through a phase of seeking to update our computer equipment and being told that there was no money available for it'* (int 20 tu 228)

Summary for resource assessment model selection factors

The following patterns of factors emerged from the data analysed in connection with the factors found to affect model selection and the types of non-traditional models selected for use within the resource assessment category, namely,

interviewees 16, 18, 21, (NQSP) 17 (QSP) were practitioners who *had an extensive cost database which was supported with networked cost information models based on stored electronic data, and who had access to support facilities in terms of computers and staff expertise which can be drawn upon from across the organisation's multi-sites, and who were situated in organisations which had open, learning cultures towards the development of new procedures,*

and

interviewees 15 (NQSP), 19, and 20, (QSP) were practitioners who had a more limited cost database which was supported with cost models, if available, which were based on individual spreadsheets rather than on networked stored electronic data, and who had access to limited support facilities within the single site of the organisation, and who were situated in organisations in which any open learning culture was left to be developed on a personal basis

8.2.5 Results and proposition (4)

The analysis of data gathered from interviewees 15-21 was undertaken in order to confirm the properties detailed in proposition (3) namely,

*‘The process of selecting building project price forecasting models was a process that was affected by the interrelationships of factors such as data availability, timescale, type, and client (**project awareness**), and factors such as approach, accuracy, and commission (**response evaluation**) together with factors such cost database, support facilities, and culture (**resource assessment**)’*

Given the data obtained and analysed from interviewees 15-21 then the above proposition can be confirmed and the model illustrated in Fig.7.9 together with its identified properties could now be considered as being grounded.

Proposition (3) also went on to suggest that the process of selecting building project price forecasting models for use was constrained by,

‘the overarching constraints of the forecaster being situated in either small or large sized quantity surveying only (QSP) or project management and multi-disciplinary (NQSP) types of organisations as well as the forecasters own level of model understanding’

The nature and scope of the study prevented the impact of model non-understanding from being addressed within the qualitative study. The data collected and analysed from interviewees 15-21 addressed the other overarching constraints of organisational type and size. Table 8.1 provides a summary of the results of the within-case data analysis undertaken to ascertain whether there were any patterns within the data in terms of the factors found to be influential and the type of non-traditional models selected for use. Accordingly, the data obtained from the interviewees who were situated in large sized organisations of differing types were assembled within the following cases, namely,

case 1 - *quantity surveying practices (QSP)* - interviewees 17,19, and 20, and
case 2 - *multi-disciplinary and project management types of organisation (NQSP)* - interviewees 16,18, and 21

The following patterns of similarities were found in the data obtained in relation to,

- * **project awareness,**
interviewees 18, 21,(NQSP) and 19 (QSP)
interviewees 15 (NQSP) and 17 (QSP)
- * **response evaluation,**
interviewees 16, 18, and 21,(NQSP)
interviewees 15(NQSP), 17 and 20 (QSP)
- * **resource assessment**
interviewees 16, 18, 21, (NQSP) and 17 (QSP)
interviewees 15 (NQSP), 19 and 20, (QSP)

Table 8.1 grouped interviewees 15-21 into their respective cases, namely (NQSP) and (QSP). Table 8.1 shows that in general the building project price forecasters who were situated in the (NQSP) types of organisation were more involved in the selection of non-traditional models than were the interviewees who were situated in the (QSP) types of organisation. Interviewees 15 and 19 provided exceptions to this general observation.

Interviewee 15 was included in this round of data gathering in order to provide a cross-case comparison. Interviewee 15 was found during the course of the interview to be situated in a smaller sized multi-disciplinary type organisation than were the other interviewees within the (NQSP) type cases. Table 8.1 provides a preliminary indication of differences across cases as it shows that interviewee 15 had differing factors that were found to influence the selection of a more restricted range of non-traditional building project price forecasting models than were the other interviewees (16, 18, and 21) that made up the (NQSP) case.

The implication of this preliminary finding was that further data needed to be collected and analysed to provide further evidence of cross-case sensitivity within the emerging constraints-based theory of factors that affected the selection of non-traditional types of building project price forecasting models.

Table 8.1 Model selection factors and models in-use - interviewees 15 - 21

Organisational Types	Multi-Disciplinary & Project Management				Quantity Surveying Practices		
Interviewees	15	16	18	21	17	19	20
Project data							
non-drawn		■	■	■		■	
drawn	□				□		□
Timescale							
urgent	□				□		
non-urgent		■	■	■		■	■
Project type							
usual	□				□		
non-usual		■	■	■		■	■
Client							
sophisticated	■	■	■	■		■	
non-sophisticated					□		□
Approach							
proactive		■	■	■		■	
reactive	□				□		□
Accuracy							
output feedback	□				□		
process feedback		■	■	■		■	■
Commission							
restricted	□				□	□	□
extensive		■	■	■			
Cost database							
limited	□					□	□
extensive		■	■	■	■		
Support facilities							
single site	□					□	□
multi site expertise		■	■	■	■		
Culture							
personal							□
organisational	■	■	■	■	■	■	
Non-trad models							
statistical			■	■			
KBS		■	■			■	
LCC	■	■	■	■	■		
risk		■	■	■		■	■
value		■	■	■	■	■	

■ = Relevant factor

□ = Relevant factor

Table 8.1 also shows that interviewee 19 did not fit the general pattern established for the interviewees within the (QSP) type of case. On reflection it was considered that interviewee 19 had a limited range of sophisticated clients which ensured that in terms of project awareness interviewee 19 matched the pattern of factors established by those interviewees who had been classified as (NQSP) type of case. However, in terms of response evaluation, and especially, resource assessment, it was found that interviewee 19 matched more closely the pattern of factors established by those interviewees who had been classified as (QSP) type cases. Therefore, the range of non-traditional models selected by interviewee 19 was non-typical of the (QSP) type of case.

The implication of these findings was that further data needed to be collected from practitioners who were situated in organisations of differing types and sizes in order to gather evidence of any cross-case sensitivity within the emerging constraints-based theory of factors that affected the selection of non-traditional types of building project price forecasting models.

In order to guide the collection of further data proposition (4) was developed from the results of the data gathered from interviewees 15-21, namely

‘A constraints-based theory of factors that affect the selection of non-traditional building project price forecasting models predicts that, as well as their own level of model understanding, forecasters who were situated in large sized project management and multi-disciplinary types of organisations who,
selected models on projects which had drawn and non-drawn data available, and which responded in urgent and non-urgent timescales on projects that were of a usual and non-usual type, and which worked with sophisticated and non-sophisticated clients,

and who

adopted a proactive approach to the provision of their building project price forecasting services, and considered accuracy to be more than just feedback on the accuracy of the model output, and which accepted an extensive range of commissions

and who

had an extensive cost database which was supported with networked cost information models based on stored electronic data, and had access to support facilities in terms of computers and staff expertise which could be drawn upon from across the organisation's multi-sites,

and which had an open, learning culture towards the development of new procedures,
were more likely to be involved with the selection of non-traditional as well as traditional types of building project price forecasting models than those forecasters who did not match the properties indicated above'

The next step in the grounding of the emerging constraints-based theory indicated in proposition (4) above was to select practitioners as further interviewees who were located in organizations of differing types and sizes and who had previously confirmed their familiarity with the selection of non-traditional building project price forecasting models on their returned participant selection forms.

8.3 Proposition (4) and an emergent grounded constraints-based theory

8.3.1 Selection rationale for interviewees 22-31

The fifth round of interviews (22-31) was conducted in the summer of 1998.

Table 6.2 indicated the general rationale from which the interviewees were selected. The selection of the interviewees for the fifth round of data collection was guided by the data analysed from interviewees 15-21 together with the quantitative evidence generated in chapter 4. Therefore interviewees 22-31 needed to be situated in both similar and different organisational types to the previous interviewees in order to facilitate further within and across-case data analysis. The cross-case data analysis was facilitated by grouping interviewees with similar characteristics together to form a group or case. Accordingly it was resolved to establish contact with practitioners who were located in large sized project management and multi-disciplinary practices (NQSP/large) - **case 1**, as well as small and medium sized quantity surveying practices (QSP/small) - **case 2**, and (QSP/medium) - **case 3**. The practitioners selected as interviewees 22-31 were as follows,

Interviewees 22, 23, 27, and 29 (NQSP/large) - respondents 1205, 1504, 1314, 285

These interviewees were situated in organisations that they had described as being either project management or multi-disciplinary in nature, and which were large in size,

i.e. more than eleven members of staff engaged in the selection of building project price forecasting models. These interviewees were formed a group which was labelled **(NQSP/large) - case 1** in order to further ground the properties of the emerging constraints-based theory of factors affecting the selection of non-traditional models that had been identified in proposition (4) as being relevant to organisations of this type and size.

The data collected and analysed from interviewee 27 were found to be out of focus with the aims of this phase of data gathering. Interviewee 27 had developed a bespoke cost model which was installed as a networked cost model across the differing offices that made up his organisation. It was found that the data gathered from this interviewee did not address the main model selection properties that had been identified in proposition (4). As a result it was decided to discard the data from interviewee 27 and contact a further interviewee from this organisational classification who subsequently became interviewee 29.

Interviewees 24, 28, and 30 (QSP/small) - respondents 2231, 1635, and 1145

These interviewees were situated in organisations that had been classified as quantity surveying practices at the participant confirmation stage. In addition they were all small in size, i.e. they employed fewer than five members of staff in the building project price forecasting model selection process. These interviewees were formed into a group which was labelled **(QSP/small) - case 2**. They were selected in order to undertake a cross-case data analysis. Such an analysis would reveal the extent of the applicability of the properties set out within the emerging constraints-based theory of factors affecting the selection of non-traditional types of building project price forecasting models. Subsequent to the collection of data from interviewee 30 it was discovered that this interviewee was situated in a project management type organisation. However, it was decided to include the data from interviewee 30 within this case as the interviewee was still situated in a small sized organisation.

Interviewees 25, 26, and 31 (QSP/medium) - respondents 195, 1991, and 1715

These interviewees were selected because they were situated in organisations which had been identified as being medium sized quantity surveying practices on the participant confirmation forms. Medium sized organisations were classified as being organisations that employed between 6-10 members of staff in the process of selecting building project price forecasting models for use. These interviewees were formed into a group which was labelled **(QSP/medium) - case 3**. They were selected in order to undertake a cross-case data analysis. Such an analysis would reveal the extent of the applicability of the properties set out within the emerging constraints-based theory of factors found to affect the selection of non-traditional types of building project price forecasting models

8.3.2 Cross-case analysis

This round of meetings (interviews 22-31) adopted a structured agenda of topics for discussion that reflected the properties that had been identified in proposition (4) as being factors within the emerging constraints-based theory of factors that affected the selection of non-traditional types of building project price forecasting models. The taped conversations of interviews 22-31 lasted on average 45 minutes. The full transcripts of the taped conversations are available as a document within the NUD*IST4 file on the disc attached to the rear of the thesis.

The data collected from interviewees 22-31 (excluding interviewee 27) were entered into the NUD*IST4 data analysis software package and were analysed to,

- (i) *Determine whether there were any patterns in the data collected from practitioners situated in organisations of different types and sizes (cases 1, 2, and 3 above) and the properties that had been identified as being relevant to the emerging constraints-based theory of factors that affected the selection of non-traditional types of building project price forecasting models.*

It was anticipated that such an analysis of the data gathered from interviewees 22-31 would provide evidence of the emerging constraints-based theory expressed in proposition (4) becoming grounded.

Table 8.2 Model selection factors and the non-traditional models selected for use - interviewees 22-31

Cases	1 - (NQSP/large)			2 - (QSP/small)			3 - (QSP/med)		
Interviewees	22	23	29	24	28	30	25	26	31
Project awareness									
drawn data				<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>		<input type="checkbox"/>
drawn/non-drawn data	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	
urgent timescale	<input type="checkbox"/>			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
urgent/ non-urgent time		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>						<input checked="" type="checkbox"/>
usual projects				<input type="checkbox"/>	<input type="checkbox"/>				
usual/non-usual projects	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
non-sophis clients					<input type="checkbox"/>				<input type="checkbox"/>
sophis/non-sophis clients	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
Response Evaluation									
reactive approach				<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>		<input type="checkbox"/>
proactive approach	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	
model output f'back				<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>
output & process f'back	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>					<input checked="" type="checkbox"/>	
limited commission				<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
extensive commission	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>						<input checked="" type="checkbox"/>
Resource assessment									
limited cost database				<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>
extensive cost database	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>					<input checked="" type="checkbox"/>	
single site support				<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>
multi site support	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>					<input checked="" type="checkbox"/>	
personal culture				<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>
organisational culture	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>					<input checked="" type="checkbox"/>	
Non-Trad models									
Statistical - spreadsheet	<input checked="" type="checkbox"/>						<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
Statistical - networked		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>						
KBS	<input checked="" type="checkbox"/>								<input checked="" type="checkbox"/>
LCC	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Risk	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>				<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>
Value		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>				<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

☒ = Relevant factor

☐ = Relevant factor

It was decided to facilitate the cross-case data analysis of factors relevant to proposition (4) by considering each of the main groups of properties related to the emerging constraints-based theory of factors found to affect the selection of non-traditional types of building project price forecasting models in relation to each of the cases 1, 2, and 3 identified above, i.e. (NQSP/large), (QSP/small), and (QSP/medium). Table 8.2 provides an illustration of the results of the cross-case analysis.

Table 8.2 provides evidence of a clear pattern of selection factors and actual types of non-traditional model selected for use in case 1 and case 2, i.e. large sized project management and multi-disciplinary types of quantity surveying organisations, and small sized quantity surveying practices. The data analysis did not support the existence of any patterns in the data generated from those interviewees who were grouped into case 3, i.e. medium sized quantity surveying practices. Therefore, it was resolved to exclude this case from the following discussion.

8.3.3 Project awareness

The properties of the emerging constraints-based theory set out in proposition (4) that were related to sub-category (a) project awareness included,

.... forecasters who were situated in large sized project management and multi-disciplinary type organisations who,
selected models on projects which had drawn and non-drawn data available, and which responded in urgent and non-urgent timescales on projects that were of a usual and non-usual type, and which worked with sophisticated and non-sophisticated clients,
were more likely to be involved with the selection of non-traditional as well as traditional types of building project price forecasting models than those forecasters who did not match the properties indicated above

Each case, as indicated above, was now considered to ascertain any patterns of cross-case factors found to affect the selection of non-traditional types of building project price forecasting models.

In general it was found that interviewees within case 1 (NQSP/large) provided evidence that matched the properties set out above in the emerging constraints-based

theory. However, it was found that interviewee 22 had a more restricted range of clients than the other interviewees in this case. The following typical comments have been drawn from across the interviewees within this case to illustrate the findings, namely,

'the movement (in model used) would depend upon the upon the level of project information available ... in some instances we would be able to determine such forecasts ... without the aid of the designers sketch plans' (int 29 tu 33-35)

'we do offer early cost advice before we have any drawn information available', (int 22 tu 63)

'such advice is often produced once there is an outline project design in existence' (int 23 tu 87)

'nature of the client type is that they operate on tight timescales and so it is not actually possible to stop and carry out a formal value engineering exercise' (int 22 tu 258)

'value engineering happens on commercial type projects over one million pounds in value and so it depends on the projects circumstances ... for instance if the project concerned was a repeated scheme then there would not be much scope for a value engineering exercise ... should the project be a one off type which is large and prestigious in nature then we would set up a formal value engineering exercise' (int 29 tu 130-136)

'the use of ELSIE depends on the type of client that you have ... in some circumstances it is used for a sophisticated client' (int 22 tu 139/154)

The interviewees included in case 2 were situated in small sized quantity surveying practices and it was generally found that the properties of the emerging constraints-based theory that were set out above did not apply to them. However, there was some evidence in the data collected from interviewee 30 that, in terms of project awareness, a wider range of project and client types was still possible within this case of building project price forecasters. Typical comments have been included below to illustrate these findings,

'the advice is typically based on very sketchy information ... and we would look at the sketch scheme drawings that were available' (int 24 tu 24/79)

'typically the project documentation that I would work from would include drawings and specifications ... although we can provide info without any drawings at all' (limited to small scale housing developments) (int 28 tu 264)

(the model selected) depends on whether the client gave us time to do a thorough investigation' (int 24 tu 14)

'we do deal with bespoke buildings which do not fall into the category of repeat projects but we do not get involved with value engineering exercises'

(int 24 tu 359)

'I find that clients have no interest in assessing the running costs of their proposed buildings' (int 28 tu 210)

8.3.4 Response evaluation

The properties of the emerging constraints-based theory set out in proposition (4) that were related to sub-category (b) response evaluation included,

.... forecasters who were situated in large sized project management and multi-disciplinary type organisations who,
adopted a proactive approach to the provision of their building project price forecasting services, and considered accuracy to be more than just feedback on the accuracy of the model output, and which accepted an extensive range of commissions
were more likely to be involved with the selection of non-traditional and traditional types of building project price forecasting models than those forecasters who did not match the properties indicated above.

Each case, as indicated above, was now considered to ascertain any patterns of cross-case factors found to affect the selection in general of non-traditional types of building project price forecasting models.

In general the data collected from the interviewees assigned within case 1 - large sized project management and multi-disciplinary types of organisations supported the properties set out above in the constraints-based theory of building project price forecasting model selection. Interviewee 29 was the only interviewee to differ within the case and that was in terms of the assessment of accuracy of forecast. Typical comments obtained from the interviewees included,

'I would say that this is a progressive quantity surveying organisation' (int 22 tu 6)
and *'when we are working with a client that is new to the industry then we like to bring our expertise to the table ... and not necessarily adopt a reactive role'*

(int 22 tu 94)

'we go out and actively seek commissions ...' (int 22 tu 249)

'...we may undertake a risk analysis exercise. I think it is not sufficient to simply wait to be asked ... this (kind of) approach is well received when one is working with educated or sophisticated clients' (int 23 tu 275)

'we find that ELSIE industrial uses rates that are too high and ELSIE commercial uses rates that are too low' (int 22 tu 140)

'I think the days of giving a single figure forecast are limited ... I think clients are prepared to forgo accuracy I clearly believe that all clients are looking for reliable early cost advice' (int 23 tu 257)

The data gathered from the interviewees assigned within case 2 - small sized quantity surveying practices did not generally support the properties of the emerging constraints-based theory set out above. Interviewee 30 provided evidence of taking a

slightly different approach to response evaluation as indicated in the comments quoted below,

'very often our clients have already got a good idea of what their buildings are going to cost before we have been approached we keep our thoughts to ourselves' (int 24 tu 332)

'no I have not used ELSIE ... I think a lot of this academic approach to early cost advice would be wasted...' (int 28 tu 221)

'we approach the determination of our figures in a rigorous manner so that we can talk about the assumptions that go behind the build up of costs so that we can get shared ownership of the costs' (int 30 tu 161)

'we always like to be as close to the lowest tender as possible' (int 24 tu 199)

'I would think that my clients expect me to be within 10% of the tenders received' (int 28 tu 158)

'we do not know what we are going to be involved with when we seek to provide this service' (int 24 tu 317)

'I do not get involved with providing life cycle costs even though I bring it to the attention of my clients ... it may be that they are too small to get involved with it .. I do not work for larger corporate clients who may be more interested in receiving this service' (int 28 tu 209)

8.3.5 Resource assessment

The properties of the emerging constraints-based theory set out in proposition (4) that were related to sub-category (c) resource assessment included,

.... forecasters who were situated in large sized project management and multi-disciplinary type organisations who,

had an extensive cost database which was supported with networked cost information models based on stored electronic data, and had access to support facilities in terms of computers and staff expertise which could be drawn upon from across the organisation's multi-sites, and which had an open, learning culture towards the development of new procedures,

were more likely to be involved with the selection of non-traditional as well as traditional types of building project price forecasting models than those forecasters who did not match the properties indicated above

Each case, as indicated above, was now considered to ascertain any patterns of cross-case factors found to affect the selection of non-traditional types of building project price forecasting models.

In general the data collected from the interviewees assigned within case 1 - large sized project management and multi-disciplinary types of organisations supported the properties set out above in the constraints-based theory of building project price

forecasting model selection whereas the data analysed from the interviewees assigned to case 2 - small sized quantity surveying practices, did not. The following comments were typical and have included below to illustrate the findings,

Case 1 - comments which were supportive of proposition (4),

'the key to developing our expertise is the way in which we are capable of carrying out a flexible analysis from past schemes undertaken across the organisation. Such feedback is stored electronically and forms a database for us to use when forecasting future schemes' (int 22 tu 106-110)

'the organisation itself is networked, we have our own intranet, we have our own bespoke cost modelling system' (int 23 tu 23)

'we have access to our own in-house cost database which is based on all the organisations projects which are collected and stored centrally in an electronic database' (int 29 tu 15)

'we do have the necessary expertise within the organisation' (value management facilitator) (int 22 tu 250)

'we work closely with architects and engineers to solve problems that have not been considered before' (int 23 tu 163)

'we have six hundred staff and this would include staff expert in a number of models' (int 29 tu 6)

'we do invest in research and development to improve the service that we offer' (int 29 tu 311)

Case 2 - comments that were not supportive of proposition (4),

'some of our cost information is quite historic and so if something appears in Building Magazine that appears useful then we keep it' (int 24 tu 120)

'the software I have is limited ... I am reluctant to spend out up to £500 for software in one go' (int 28 tu 22)

'we have one computer between the three surveyors involved in the provision of early cost advice' (int 24 tu 8)

'I am a sole practitioner working from home ... I have to say that I am not up to providing the service. (value management)' (int 28 tu 6/230)

'we employ three surveyors ... this is the only office in the organisation ... we do not use any proprietary software... we do not subscribe to the BCIS' (int 30 tu 48-50)

'I suspect that the take-up and use of expert systems is to do with the size and nature of an organisation and especially its own culture and approach to research and development' (int 30 tu 432)

8.3.6 An emergent grounded constraints-based theory

The cross-case data analysis indicated above and illustrated in Table 8.2 indicated that the interviewees grouped into case 1 supported the selection factors set out in proposition (4) and selected a variety of non-traditional types of building project price forecasting models. The interviewees that were grouped into case 2 did not support

the selection factors set out in proposition (4) and selected few if any of the non-traditional types of building project price forecasting models. The data generated by the interviewees grouped into case 3 was shown to be inconsistent and did not provide a pattern between the types of factors found to be influential and the non-traditional models selected for use.

Therefore, it was concluded that proposition (4) was grounded in terms of the experiences of the interviewees grouped into case 1 and case 2. In terms of the emerging constraints-based theory of factors found to affect the selection of non-traditional types of building project price forecasting models it can be concluded that the relative polar extremities of the overarching constraint of organisational type and size had now been identified. These findings have been incorporated into an emergent grounded constraints-based theory as indicated below,

‘An emergent grounded constraints-based theory of factors that affect the selection of non-traditional building project price forecasting models predicts that, as well as model understanding, forecasters who were situated in large sized project management and multi-disciplinary types of organisations and who,

select models for projects which had drawn and non-drawn data available, and who responded in urgent and non-urgent timescales to sophisticated and non-sophisticated clients on projects that were of a usual as well as non-usual in type,

and who

adopt a proactive approach to the provision of their building project price forecasting services, and consider accuracy to be more than just feedback on the accuracy of the model output, and which accept an extensive range of commissions

and who

have access to an extensive cost database which was supported with networked cost information models based on stored electronic data, and have access to support facilities in terms of computers and staff expertise which could be drawn upon from across the organisation's multi-sites, and who have an open, learning culture towards the development of new procedures,

were more likely to be involved with the selection of non-traditional as well as traditional types of building project price forecasting models than those forecasters who were situated in small sized quantity surveying practices who did not match the properties indicated above’.

Fig. 8.1 and Fig. 8.2 illustrate the emergent theory in terms of the extremes of its overarching constraints of organisational type and size. Each condition of the theory at its polar extremities is illustrated together with the predicted model selection factors and the other overarching constraint of the building project forecasters own lack of model understanding. Fig. 8.1 illustrates the constraints-based theory and its features within a small sized quantity surveying practice which provides a traditional range building project price forecasting advice services to its clients. Fig. 8.2 illustrates the situation in large sized project management and multi-disciplinary types of organisations. Fig. 8.2 illustrates the additional features found within the constraints-based theory that apply to this organisational setting. Fig. 8.2 shows that in these types of organisations the non-traditional building project price forecasting models or tools are seen as an additional set of tools that can be called upon to provide solutions to the additional service demands of some of their clients.

The factors related to the building project price forecasting model selection conditions of those interviewees situated in organisational types and sizes between the polar conditions identified in Fig. 8.1 and Fig. 8.2 remain to be grounded

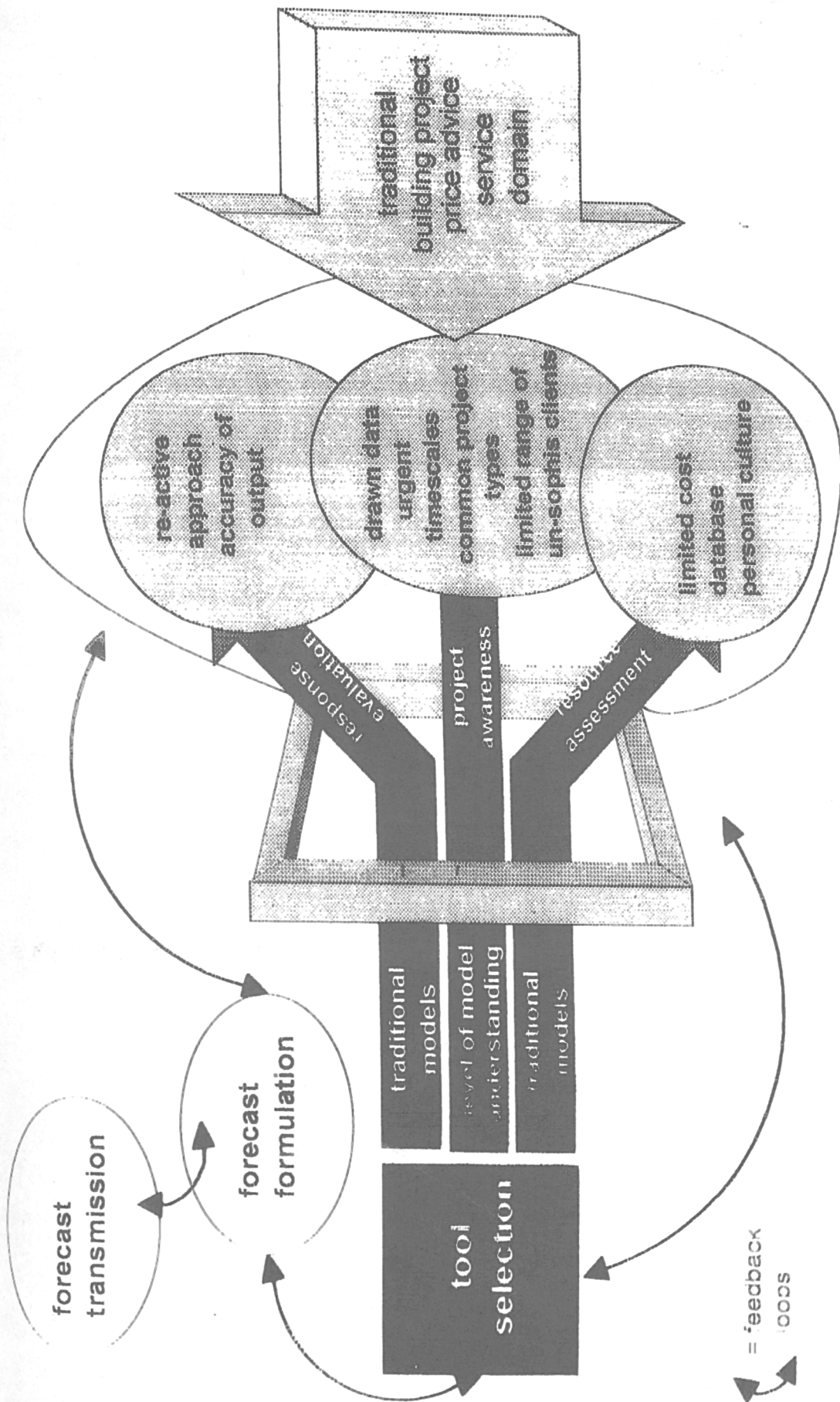


Fig. 8.1 An emergent grounded constraints-based theory of factors affecting the selection of building project price forecasting models in small size quantity surveying practices

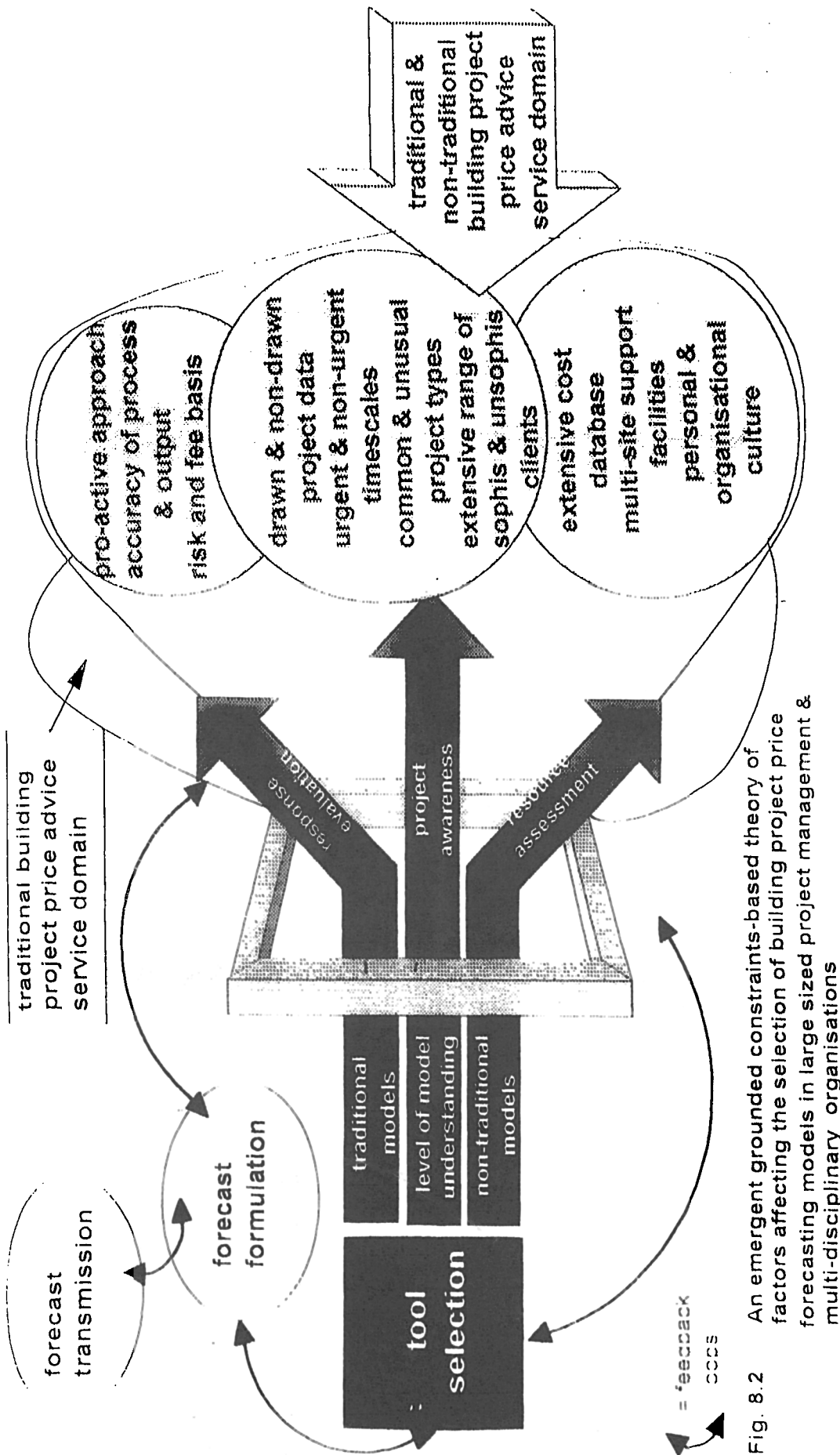


Fig. 8.2 An emergent grounded constraints-based theory of factors affecting the selection of building project price forecasting models in large sized project management & multi-disciplinary organisations

8.4 Summary and reflections on the research process

8.4.1 Summary

This chapter reported the research undertaken to ground an emergent constraints-based theory of factors found to affect the selection of non-traditional types of building project price forecasting models. The chapter detailed the rationale for the selection of interviewees 15-21 and 22-31 who provided data in two rounds of activity. The data collected were analysed within the NUD*IST4 data analysis software package to determine the appropriateness of proposition (3) and proposition (4). As a result of the analysis it was possible to ground an emergent constraints-based theory and identify its conditions at the opposite ends of its organisational size and type continuum. The chapter concluded by advancing an emergent constraints-based theory which was illustrated in terms of its conditions at the extremes of its organisational constraints in Fig. 8.1 and in Fig. 8.2. The emergent constraints-based theory of factors found to affect the selection of non-traditional building project price forecasting models identified the factors that could predict the likelihood of building project price forecasters being able to select non-traditional as well as traditional types of models when they were situated in either a large sized project management or multi-disciplinary type of organisation, or a small sized quantity surveying practices.

8.4.2 Implications for further work

The work reported above yielded the fruits of an initial exploration of the territory associated with the factors affecting the selection of non-traditional types of building project price forecasting models. As a result, particular features of the territory, in terms of general model selection factors and their grouping has been advanced and grounded in the experiences of practitioners involved in the model selection process.

The emergent constraints-based theory advances sets of factors which have been grounded in the experiences of practitioners situated at opposite poles of the axis containing organisational type and size. More work is needed to further unravel the impact of the remaining overarching constraint, namely, lack of model understanding together with the mapping of constraints-based factors related to forecasters situated

in medium sized organisations of differing types. In addition further work is required to assess the extent of inter-relatedness between the main categories of model selection factors in terms of the individual types of non-traditional models that have been found to be available. This further work is outside the scope and resources available for this present study.

8.4.3 Reflections on the research process undertaken

The research undertaken and reported on in this chapter marks an end of this particular journey through this topic at this time. It also marks the starting point for other work of a similar nature in the future. The activities involved in the selection, execution, analysis, and presentation of data collected in two further rounds of activity within this chapter provided a vehicle by which the researcher developed real skills in qualitative research methods which would enable further work in this topic area to be carried out in a robust manner.

The collection and analysis of over 110,000 separate pieces of data gathered from interviewees 15-31 would not have been possible without the indexing framework, flexibility, thoroughness, and reliability of the NUD*IST4 software package. The researcher is now a confirmed fan of the software package and looks forward to its continued improvement especially in terms of its ability to present its results in a more visual manner.

Chapter 9

Emergent Issues

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Chapter 9

Emergent Issues

9.1 Introduction

This research sought to develop a greater understanding of how the factors that affected the selection of non-traditional types of building project price forecasting models influenced practitioners who were involved in the process of building project price forecasting. This was achieved by ascertaining what types of models were in actual use and how and why construction professionals in the field selected particular types of building project price forecasting model(s) for use.

This chapter considers the main findings that have emerged from both the quantitative and qualitative investigations that were carried out in sections two, three, and four of this thesis. The emergent issues that arose from those investigations have been considered in the light of the study's main findings. The impact of the study's main findings have been discussed in terms of their contribution to what is already known in theory, and in practice, about building project price forecasting models in-use, and the general factors that have been found to affect the selection of types of building project price forecasting models.

Given the findings in the thesis, this chapter also considers the potential future research directions that other academics may wish to pursue in order that further contributions to knowledge can be made in the topic area. The chapter concludes by reflecting on the originality of the research process that was adopted for the thesis and considers its contribution to the methodological debate current in the construction management academic discipline.

9.2 Implications of results of quantitative investigation

9.2.1 Generally

The thesis undertook two quantitative data collection exercises. The first exercise involved a full population mailed survey of the 2327 quantity surveying organisations that were operating in England in 1997. The second exercise was undertaken in phase two of the study, and it collected data on the perceived importance of potential model selection criteria via a mailed survey of a sample 167 informed practitioners. The response rates achieved for the nation-wide mailed survey was 55.7 %, and 58.2% for the more limited survey. The results of the first data collection exercise were considered as reliable, given the absence of sampling bias and the high response rate achieved. The results of the second data collection exercise were considered as biased due to the nature of the informed practitioners selected as its sample. Nevertheless, emergent issues connected with the results from each of the data collection exercises have now been considered, and their impact in terms of building project price forecasting theory and practice assessed.

9.2.2 Building project price forecasting theory

Chapter 2 considered the theory related to the building project price forecasting process. Literature was reviewed in order to determine the significance of the building project price forecasting process to clients and practitioners. The nature of what was known about the building project price forecasting process itself was established and illustrated in Fig. 2.2. The main thrust of this work was identified as being centred on the investigation, and the model application stages of the complete building project price forecasting process, as defined in Bowen's (1995) communications-based theory of building project price forecasting.

Having set the scene the thesis then considered previous theoretical work in the area in order to identify any gaps, conflicts, and mandates for further work in the topic area. A major gap in the previous work was identified by Raftery (1993) who asserted that there was a general lack of empirical evidence of actual, as opposed to theoretical assertions of

practices that were prevalent in building project price forecasting. The literature reviewed in chapter 2 of the thesis identified several theoretical contributions that could be considered as '*flares*' that lit up the features of the building project price forecasting research agenda, and which between them provided the stimuli for this work. In terms of this study the following were seen as being instrumental in giving it its original mandate, namely, papers by Raftery (1993), Newton (1991), Skitmore (1991), Bowen and Edwards (1985), and Brandon (1982).

The calls for further work they made, the gaps that they identified, and the predictions of future trends that they made were all detailed in the literature reviewed in chapter 2. Together, they gave the following focus to the initial quantitative investigation within this study, namely to, (i) identify the building project price forecasting models in-use in England. The achievement of this objective would enable the nature of any paradigm shift towards the newer non-traditional types of building project price forecasting models, as had been predicted to happen by Brandon (1982), to be identified. A second thrust to the work within this phase of the study was to, (ii) identify the organisational types, sizes, and location of quantity surveying organisations that were more likely to be involved in using the newer non-traditional types of building project price forecasting models.

The results of the nationwide survey were illustrated in Figs. 3.1 and 3.2. The results indicated that, in general terms, construction professionals have not yet answered the call of academia to adopt the newer non-traditional, mainly computer based, stochastic models that assess project risk and uncertainty. Traditional types of models, that provide single point deterministic building project price forecasts, continue to be the most popular types of models used by practitioners involved in the investigation and formulation of building project price advice for clients.

As a consequence of the above it was concluded that the paradigm shift called for by Brandon (1982) had not yet been generally achieved. In particular, it was found that,

- * the cost per m², approximate quantities, and elemental analysis types of techniques had the highest incidence in-use of the traditional types of models

- * the non-traditional types of building project price forecasting models, such as, statistical models, knowledge based, life cycle models, resource / process models, risk, and value related models were also in-use, but not to any general extent. The life cycle, risk and value related models were the more likely types of non-traditional models to become more widely used in the future.
- * No evidence was found of the use of the following techniques which had been suggested as being in-use by other academics in the field, namely,
 - ‘the conference method, the comparison method, the cubic method, the storey-enclosure method, the graphical method, the superficial perimeter method, the exponent method, the financial method, the dynamic and linear programming method’

As a consequence of these findings standard textbooks by Seeley (1985, ch.6), Brandon (1990, p.82), Raftery (1991, p.172), Ferry and Brandon (1994, ch.9), Ashworth (1994, p.86, and 1996, p.214), and Morton and Jaggar (1995, p.292) need to be amended to reflect the actual practices of building project price forecasters on the ground. More recent texts such as Ashworth (1999, p.246) are taking cognisance of what has been revealed as being current practice in that the above models are still being listed as available for use but they are now acknowledging that they may not be used in practice.

Furthermore, material asserted within the following refereed technical and research reports have been shown to be inaccurate, namely, Raftery (1991, section 5) and Skitmore (1991, p.16). Conflicting evidence was also revealed in terms of the types of models found to be in-use in England and the types of models found to be in-use in Nigeria by Akintoye *et al* (1992), and in South Africa by Bowen and Edwards (1998).

The literature reviewed in chapter 2 revealed the existence of differing schools of research which were termed as being either the model-centred school of research, as championed by Skitmore (1990), Newton (1991), and Aouad *et al* (1994, 1998), and the people-orientated school of research, as championed by Raftery (1993), Bowen (1995), and Lowe (1998). The results of this survey and the absence of any general paradigm shift in practice have indicated that it would be appropriate for a ‘third way’ to become

established in building project price forecasting theory which would see an 'applications-based' school of research become established.

Such a school of research needs to recognise that continued development of new models using new technologies have little chance of widespread adoption by building project price forecasters in the field unless they are developed with the needs of the practitioners, their clients, and the forecast preparer's organisational setting in mind. The survey results also indicated that the newer non-traditional models were not being used as replacement forecasting models or tools, rather there was evidence to suggest that the newer non-traditional models were being used as additional tools by the practitioners concerned, to enable them to cope with specific circumstances.

This evidence prompted the further exploration of the data collected from the nation-wide survey in order to assess the impact of its findings upon practice in general.

9.2.3 Building project price forecasting practice

Building project price forecasting was identified by Male (1990) as being one of the services provided by quantity surveyors that could be considered as being truly professional. Evidence of the relevance of the work to the profession can be judged by the fact that the research was supported financially by the RICS Education Trust. Therefore, a profile of what models were in-use and where, in terms of organisational setting, the newer types of non-traditional models or tools were being used as an aid to practitioners who were involved in the dispensation of this professional service would be of use to the profession at large.

Accordingly, it was resolved to manipulate the data collected from the full population survey to identify the organisational types, sizes, and geographical location of quantity surveying organisations that were more likely to be involved in using the newer non-traditional building project price forecasting models or tools. Chapter 4 detailed the application of the appropriate statistical tests to the data and the resultant findings were that, *'building project price forecasters who were situated in either large sized multi-*

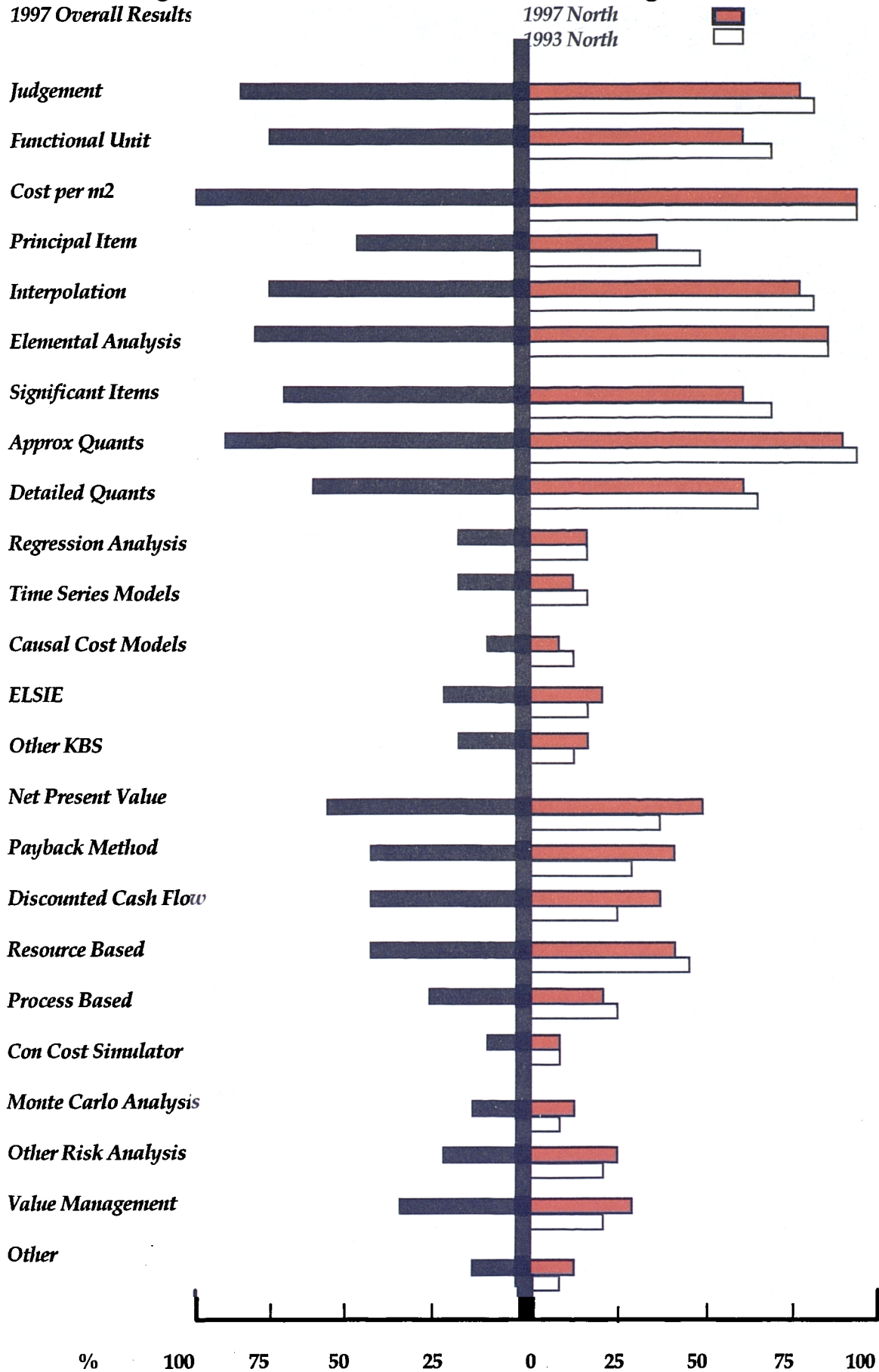
disciplinary or project management types of organisations, irrespective of geographical location, were more likely to be involved in the selection of non-traditional building project price forecasting models than were building project price forecasters who were not'.

The finding that there were no statistically significant differences in the incidence-in-use of types of models being used in organisations that were situated in different parts of England (including London) directly answered Fortune and Lees' (1996, p.40) concerns about the potential for bias in the results of their regional survey of building project price forecasting models in-use. This smaller regionally based survey was carried out in 1993 and had taken an initial snap-shot of the incidence in-use of the traditional and non-traditional models that were then currently being selected for use.

On further manipulation of the data collected from this nation-wide survey it was possible to directly compare the building project price forecasting models that were selected for use by organisations which were located in the north of England and who responded to both 1993 and 1997 surveys. Such a comparison determined whether there was any movement in the types of models being selected for use. Fortune and Hinks' (1998) paper provided a detailed assessment of the results of the 1993 and 1997 data collection exercises. Fig. 9.0 summarises the results. The left-hand side of the diagram (LHS) shows the results of the 1997 nation-wide survey, and the right-hand side (RHS) shows the models that were found to be used by practitioners situated in organisations which were located in the north of England in 1993 and 1997.

In general the results of this analysis indicated that traditional types of models that provided single-point deterministic building project price forecasts had a reduced incidence in-use, amongst the organisations indicated above, between 1993 and 1997. In addition, Fortune and Hinks (1998) observed that there had been some increases in the use of the newer types of non-traditional models, such as life-cycle costs, monte carlo and other risk analysis models, amongst the same organisations and during the same time period as indicated above. Fortune and Hinks (1998) pointed out that although the

Fig 9.0 - Incidence of models in-use North of England 1993-1997



increase in the usage of non-traditional types of building project price forecasting models was not statistically significant it did signal that the called for change in paradigm may not be entirely abandoned. The reasons for this increase in usage could not be addressed by the quantitative research design adopted for the first phase of the work.

The quantitative data collected, when subjected to statistical analysis did indicate that organisational type was found to be a significant factor in the incidence in-use of non-traditional building project price forecasting models. It was found that multi-disciplinary and project management types of quantity surveying organisations had a statistically significant higher level of incidence-in-use of particular types of models. It may well be the case that quantity surveying organisations that classify themselves as being, either a project management or multi-disciplinary organisation in this manner constitute the leading edge of organisational forms within building project forecasting practice, and as such, they are in the process of redefining the building project price forecasting paradigm. Fortune and Hinks (1998, p.25) concluded that although the paradigm shift in practice related to the investigation and formulation of reliable early cost advice was not yet generally achieved *'there was some evidence to suggest that, amongst multi-disciplinary and project management types of organisations, it may, as yet, only be postponed.'*

Hinks (1998, p.233) advanced the conceptual link between *'process capability and information technology implementation'* in terms of the capability of organisations to provide valued services. Hinks (1998, p.233) claimed that there existed an opportunity for organisations to develop a *'co-maturation'* of services offered and information technology adopted and utilised. Although the thrust of Hinks' work was in the facilities management sphere a parallel can be drawn, given the results of the nation-wide survey undertaken in phase one of this study, to the organisations providing building project price forecasting services. The reluctance of building project price forecasters to adopt the paradigm change called for by Brandon (1982) demonstrates that, in general, the quantity surveying profession has failed to embrace the potential for information technology to fundamentally re-design its business processes. The survey shows that for

Chapter 10

CONCLUSIONS, LIMITATIONS, AND RECOMMENDATIONS FOR FUTURE WORK

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Fortune and Lees (1996, p.40) that lack of model understanding was a 'major factor' which prevented practitioners from selecting non-traditional types of building project price forecasting models for use. This matter was addressed in the previously reported population survey of quantity surveying organisations that were operating in England in 1997. Fig.3.2 illustrated the results of the survey which generally showed that lack of model understanding was a factor, but not a dominant factor, that affected the selection of the majority of non-traditional types of models. Lack of model understanding was the main factor that affected the non-use of causal models and the construction cost simulator types of non-traditional models, but it was generally found that other factors affected the selection of non-traditional types of building project price forecasting models as well as lack of model understanding.

Fortune and Hinks (1999) commented on these survey results together with the results of the literature review indicated above to call for further work to be undertaken to identify and assess the impact of the other more positive factors that affect practitioners involved in the building project price forecasting model selection process.

Accordingly, it was decided to confirm the relevance of the more positive factors identified from the subject specific and general business literature reviewed in chapter 5. A data collection exercise was undertaken with 167 practitioners who had indicated that they would be willing to participate in further follow-up work on the nationwide survey. The twenty-eight model selection factors were scored for importance by the non-representative sample of practitioners indicated above and it was found that the following were the most influential, namely,

'(i) amount of project data available, (ii) data needed for the model, (iii) forecasters understanding of the model, (iv) time available for the forecast preparation, (v) project type, and (vi) accuracy'

Other empirical work in the area, notably by Bowen and Edwards (1998), and Akintoye (1992) reported small scale empirical studies with practitioners in South Africa and Nigeria. The results indicated above when compared with the results obtained from practitioners in Nigeria and South Africa revealed a lack of consensus in academe over which criteria could be considered to be more important. The results of this empirical

study and the others quoted above did provide evidence that accuracy of model output was not the single criterion upon which building project price forecasters discriminated between different types of traditional and non-traditional models.

This finding challenges the principle at the heart of what the study identified as being the hard edged or model centred school of research associated with building project price forecasting. Such a school placed accuracy of model output as being the main factor by which practitioners discriminated between types of model. Such a hard edged school of research had been initially championed by Ogulana and Thorpe (1987, p.45) who had claimed to have established the state of the art as a result of their work on comparative model output performances. This finding together with the other empirical studies reported above challenges the idea that accuracy of model output is the sole criterion by which practitioners choose between differing models.

Subject specific textbooks such as those by Ferry and Brandon (1991), and Ashworth (1994) have indicated that they thought accuracy of model output was the most significant factor in building project price forecasting have been shown by the findings of this study to be in error. The findings above also contradict other empirical evidence provided by Bowen (1998) on the criteria thought to influence practitioners in South Africa. The findings above have shown that to assert that accuracy of model output is the single most important selection criterion used by practitioners to discriminate between building project price forecasting models has been shown to be naive. The numbers of separate factors that have been identified as having an impact on the building project price forecasting model selection process indicates that in terms of model selection its optimisation is a complex process. The enhancement of clients business decisions via the provision of quality building project price forecasting advice has at its core the optimisation of the forecasting model selection process. The work undertaken in this study has shown that researchers in the field need to adopt a broader view on accuracy and quality enhancement in terms of building project price forecasting model selection. This approach has been endorsed by Ashworth (1999, p.258) in what is the most recently published subject specific textbook available. Ashworth acknowledges the

work undertaken within this study and now indicates that practitioners choose models on the basis of more than just accuracy alone. For instance Ashworth (1999, p.258) asserts that the choice of building project price forecasting model depends upon factors such as *'time available, project information, cost data, preference and familiarity, as well as the experience of the surveyor'*. This text was clearly published after the collection of data for this study but what is noticeable is that *time available, project information, and cost data* were factors that were also identified as being grounded sub-categories of model selection factors by this study.

The confirmation of the relevance of the selection factors identified in the literature reviewed in chapter 5 also demonstrated that the complexities of the building project price forecasting model selection process were more intricate than academe had previously considered. For instance work by Skitmore (1991, p.288) in which he suggested that by considering *'the type of project, the level of information available, and the feedback system used'* it would be possible to predict which technique should be selected, as well as work by Bowen (1995, p.30 and p.33) which asserted that the choice of model could be determined by considering, *'the amount of design information, the informational needs of the model, and the interpretation of the model's output'*, have now been shown to be inadequate and as such a re-focused research agenda in the topic area needed to adopt a broader approach.

Such a broader approach to quality and its assessment in terms of the provision of building project price forecasts requires 'quality' to be considered as a measure of the satisfaction obtained by the purchaser of the forecasts. The adoption of this broader definition of 'quality' in terms of the research agenda on building project price forecasting will mean that researchers in the field shall have to embrace a multi-stranded approach that addresses the full human processes involved in forecast formulation, transmission, and reception by the client. Recent work undertaken by researchers, such as Dawood and Bates(1998), and Elhag and Boussabaine (1998), which concentrates on the development of tools that only try to ensure that the client is provided with accurate

early cost advice will have to be seen in the wider context of the multi-stranded research themes on quality and its enhancement which have been indicated above.

It was recognised that to broaden the research agenda on building project price forecasting model selection and further extend the boundaries of what was known about the model selection process it would be necessary to move away from the research approach adopted in the previous work that had been reported. Therefore it was resolved to conduct a number of in-depth interviews with informed practitioners in the field in order to learn more of the factors that they actually rather than theoretically used to discriminate between traditional and non-traditional types of building project price forecasting models. This approach supported the call of Raftery (1993) for academe to take more account of the human side of the building project price forecasting process.

A total of thirty-one interviews were conducted in separate rounds of activity in order to develop a greater understanding of how the factors that affect the selection of non-traditional types of building project price forecasting models in general, impact on the model selection processes of construction professionals situated in differing organisational settings.

The process by which this qualitatively based study has made a contribution to what is known of the model selection process can be viewed by referring to the differences between what was known of the process itself at the start of the work (see Fig. 2.2) through the various propositions and propositional models made during the progress of the work and shown in Figs. 5.2, 6.6, and 7.9.

As a result of the data collected and analysed it was found that the study was able to advance for the first time a set of model selection factors that had been grounded in practitioner experience. The factors that were identified were classified into the following conceptual categories, namely,

project awareness, response evaluation, and resource assessment.

and that within the conceptual categories of factors that had been found to affect the selection of non traditional types of building project price forecasting models were the following sub-categories of factors, namely,

'data, timescale, type, client, (project awareness), approach, accuracy, commission, (response evaluation), cost database, support facilities, and organisational culture, (resource assessment)'

In addition the work found evidence of what it termed to be overarching constraints on the building project price forecasters who were involved in the non-traditional model selection process. It was found, for the first time, that such constraints were related to the forecasters' organisational setting in terms of its size and type, and the forecasters own lack of model understanding. An emergent constraints-based grounded theory of the factors affecting building project price forecasting model selection was advanced which was defined at the extremities of its organisational continuum. The emergent theory was illustrated in Figs. 8.1 and 8.2 which represented the factors relevant to large sized project management and multi-disciplinary types of organisations as well as small sized quantity surveying practices.

9.3.3 Building project price forecasting practice

Aouad *et al* (1999) recognised that the professionals within the construction industry have become '*frustrated with the failings of IT*' and that new work is currently underway to re-address this situation which seeks to '*develop IT systems that support business processes by taking into account process, people, and cultural needs*'. The nationwide survey undertaken in phase 1 of this study revealed, in general, that the newer computer based non-traditional types of models have not been adopted by the quantity surveying profession at large. This qualitative work with practitioners, who were situated in a variety of organisational settings, has begun to build a picture of the needs and cultural approaches of the people involved with the selection of different types of building project price forecasting models. The data generated can be used by others to develop new IT based approaches to the formulation and delivery of this building project price forecasting advice service to clients that will be useful to senders and receivers of

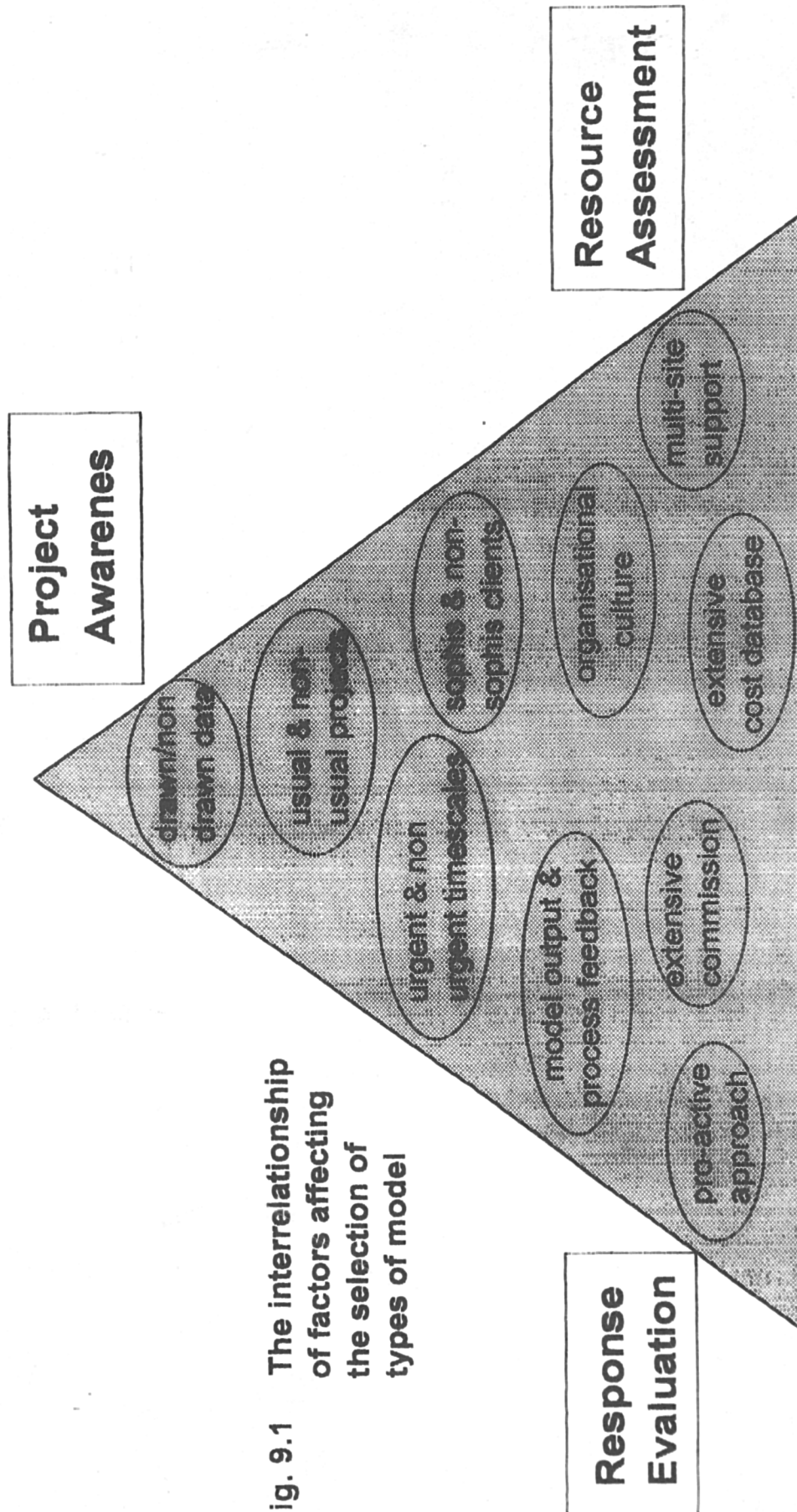


Fig. 9.1 The interrelationship of factors affecting the selection of types of model

the service and as a result become widely adopted as standard practice. In the meantime, the results of this qualitative investigation with building project price forecasters has started the process by which a model selection tool or best practice guide can be developed.

9.4 Future directions in building project price forecasting research

The findings of the qualitative investigation into factors affecting the selection of types of building project price forecasting models have been incorporated into an emergent grounded constraints-based theory which was set out in Chapter 8. Future work should seek to further refine the properties embodied within the theory in order for it to be able to address issues facing practitioners situated in medium sized organisations of differing type. The research map of the building project price forecasting model selection process now available as a result of this study has now been well defined in terms of identifying its major 'features'. What still remains to be explored is the extent and depth of the relationships between the differing model selection factors so far established in order to establish the topography of the features that have already been found. Fig. 9.1 together with Figs. 8.1 and 8.2 capture what has been discovered in terms of the general factors found to affect the selection of building project price forecasting models and together they provide the framework for future studies in the topic area.

9.5 Reflections on the research process adopted for the thesis

The combined two-phase research design adopted for this thesis could only have been achieved with the assistance of the Education Trust of the Royal Institution of Chartered Surveyors. It was a demanding approach that called for rigour at each step of the way. As a result it is possible to be confident that the findings claimed for the work are reliable. The rigorous approach adopted demanded that its methodology was checked at periodic intervals. Such measures have already allowed the study to generate four refereed papers at international research conferences, and two papers in refereed

academic journals. The comments and guidance offered by the referees concerned helped ensure that the study itself was able to generate reliable findings.

The qualitative work with quantity surveying practitioners was a novel approach for the practitioners concerned who have as a population no tradition or culture of being involved with academic research. The full population survey of all quantity surveying organisations that were operative in England in 1997 has enabled a profile of the population to be established for the first time. As a result other researchers considering a quantitative approach to data collection from such organisations can now confidently draw up representative samples of data for analysis.

The two-phased combined approach adopted for the study answered the call of Chau *et al* (1998) for research in construction management to adopt pragmatic solutions to their research problems, and as a result not get drawn into introspective academic debate over the claimed advantages of one research approach over another

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Chapter 10

**CONCLUSIONS, LIMITATIONS, AND
RECOMMENDATIONS FOR FUTURE WORK**

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Chapter 10

CONCLUSIONS, LIMITATIONS, AND RECOMMENDATIONS FOR FUTURE WORK

10.1 Introduction

This chapter sets out the main conclusions that have been drawn in connection with the aims and objectives that were established for the study in chapter 1, section 1.2. In addition, the limitations of the study have been identified and a series of recommendations for further work in this topic area have been advanced.

10.2 Conclusions

10.2.1 Generally for academe

This research firstly, mapped out ‘the state of the art’ in terms of building project price forecasting and found that the paradigm shift away from the traditional types of building project price forecasting models, called for by Brandon (1982), had not yet been achieved. The work then, secondly, ‘explored the territory’ related to the reasons why the newer non-traditional types of building project price forecasting models were not being selected for use. The work identified a number of general factors that were found to affect the selection of the non-traditional types of building project price forecasting models. The study also generated a grounded constraints-based theory of factors found to affect the selection of non-traditional types of building project price forecasting models. The emergent theory identified the parameters that needed to be in place before types of quantity surveying organisations could become generally involved with the selection of non-traditional types of models.

In terms of the particular objectives set for the work in chapter 1, section 1.2 then the following conclusions have been drawn;

Objective 1

‘to identify the types of building project price forecasting models in-use in England in order to identify the nature of any paradigm shift towards the newer non-traditional types of building project price forecasting models, as had been predicted by Brandon (1982)’.

The consideration of this objective was guided by the following hypothesis,

‘(i) the paradigm shift towards the newer non-traditional types of building project price forecasting models called for by Brandon (1982) has not yet been generally adopted by construction professionals involved in the investigative and formulative phases of the building project price forecasting process’

As a result of this study it can be concluded that the above hypothesis was not rejected as in general it was found that the paradigm shift called for by Brandon (1982) had not yet been generally achieved. In particular, it was found that,

- * The traditional group of single point deterministic models had the highest incidence in-use amongst building project price forecasters active in England in 1997. In particular, the cost per m², approximate quantities, and elemental analysis types of techniques had the highest incidence in-use of the traditional group of models listed on the questionnaire form.
- * The non-traditional types of more stochastic building project price forecasting models, such as, statistical models, knowledge based, life cycle models, resource / process models, risk, and value related models were also in-use but not to any general extent. Evidence suggested that the life cycle, risk, and value related models were the more likely of the newer types of non-traditional models to become more widely used in the future.
- * No evidence was found of the use of the following techniques which had been suggested as being in-use by other academics in the field, namely,
 - ‘the conference method, the comparison method, the cubic method, the storey-enclosure method, the graphical method, the superficial perimeter method, the exponent method, the financial method, the dynamic and linear programming method’

The main characteristics of the population of quantity surveying organisations in England in terms of type and size were determined for the first time as a result of this work, the profile of quantity surveying organisational types and sizes was established as follows,

- * The population of quantity surveying organisations in England was made up of organisations that styled themselves as being, quantity surveying practices - 70.9%, multi-disciplinary practices - 10.1%, project management consultants - 9.4%, and others 9.6%.
- * The size of organisations, in terms of the numbers of practitioners involved with the building project price forecasting model selection process were found to be as follows, one member of staff - 25.8%, between 2 and 5 members of staff - 45.7%, between 6 - 10 members of staff 17.5%, and with more than 11 members of staff - 11.0%.

These findings enable any future survey work with quantity surveying organisations in England to determine representative samples of the population.

Objective 2

to identify the organisational types, sizes, and geographical locations of quantity surveying organisations that were more likely to be involved in using the newer non-traditional building project price forecasting models

The consideration of this objective was guided by the following hypotheses,

- (ii) organisations located in the north of England would have a lower incidence of non-traditional types of model use than organisations which were located in the south of England (including London).
- (iii) there would be no difference in the incidence of non-traditional types of models selected for use between quantity surveying organisations of different types and sizes.

As a result of this study it was found that hypotheses (i) and (ii) could be rejected, as it was found that,

- * There were no differences in the frequency of model(s) incidence in-use by building project price forecasters who were situated in organisations which were located in either the north or the south (including London) of England.

This result was statistically significant across the newer non-traditional types of building project price forecasting models at the $p < 0.05$ level.

- * Quantity surveying practices had lower frequencies in use of non-traditional types of models when compared to multi-disciplinary and project management types of organisations. This result was statistically significant across the newer types of non-traditional building project price forecasting models at levels between $p > 0.01$ and $p < 0.05$.
- * Quantity surveying practices with either a 1:1 ratio of staff to computer workstations or no computer workstations at all had a lower frequency in-use of non-traditional types of models when compared to similar types of multi-disciplinary and project management types of organisations. This result was statistically significant across the non-traditional types of building project price forecasting models at levels between $p < 0.01$ and $p < 0.05$
- * Quantity surveying practices with either one, or between two and five members of staff engaged in the building project price forecasting advice process had a lower frequency in-use of non-traditional types of models when compared to multi-disciplinary and project management types of organisations. This result was significant across the non-traditional types of building project price forecasting models at levels between $p < 0.01$ and $p < 0.05$.

Therefore, it was concluded, in relation to objective 2 that building project price forecasters who were situated in either large sized multi-disciplinary or large sized project management types of organisations, irrespective of geographical location, were more likely to be involved in the selection of non-traditional building project price forecasting models than were building project price forecasters who were not.

Objective 3

To identify factors that affect the selection of building project price forecasting models and establish which of them could be considered as being more influential.

The consideration of this objective was guided by the following hypotheses

(iv) Lack of model understanding would be the major reason why quantity surveying organisations were less likely to use the newer non-traditional types of building project price forecasting models

(v) Practitioner perceptions related to lack of model output accuracy of the non-traditional types of building project price forecasting models would be the main factor used by practitioners to discriminate between different types of models in-use.

As a result of this study it was found that hypotheses (iv) and (v) could be rejected, as it was found that,

- * Lack of understanding was a factor, but not a dominant factor, that affected the selection of the majority of non-traditional types of models. Lack of model understanding was the main factor that affected the non-use of causal models and the construction cost simulator types of non-traditional models but it was generally found that other factors affected the selection of non-traditional types of building project price forecasting models as well as lack of model understanding.
- * Accuracy of model output was not the single criterion upon which building project price forecasters discriminated between different types of non-traditional models.
- * A total of twenty-eight separate factors were identified from relevant literature and when scored for importance by a non-representative sample of practitioners who were involved in the building project price forecasting model selection process it was found that the following were the most influential, namely,
 - ‘(i) amount of project data available, (ii) data needed for the model, (iii) forecasters understanding of the model, (iv) time available for the forecast preparation, (v) project type, and (vi) accuracy’

The identification of such independent factors and their scores for perceived importance had not been undertaken in England before and although useful it did not by itself aid the understanding of how they inter-related and how they impacted upon

types of non-traditional model selection. Therefore it was decided to pursue the following further objective;

Objective 4

‘to develop an understanding of how the factors that affect the selection of non-traditional types of building project price forecasting models in general impact on the model selection processes of construction professionals situated in differing organisational settings’

The consideration of this objective was guided by the following initial indicative proposition,

‘The selection of non-traditional types of building project price forecasting models was affected by the inter-relationship between factors related to a business unit’s organisation, operation, location, and factors related to the forecast model, the forecast preparer and the forecast user’.

As a result of this study it was found that the indicative proposition set out above needed to be revised in order to reflect the following findings,

- * The selection of non-traditional types of building project price forecasting models was affected by factors which were classified into the following conceptual categories, namely,

project awareness, response evaluation, and resource assessment.

- * The conceptual categories of factors found to affect the selection of non-traditional types of building project price forecasting models consisted of the following sub-categories of factors, namely,

‘data, timescale, type, client, (project awareness), approach, accuracy, commission, (response evaluation), cost database, support facilities, and culture, (resource assessment)’

In addition it was found that there were overarching constraints on the building project price forecasters who were involved in the non-traditional model selection process. It was found, for the first time, that such constraints were related to the forecasters’ organisational setting in terms of its size and type, and the forecasters own lack of model understanding. The impact of such overarching issues was investigated in response to the following objective,

Objective 5

‘to develop a grounded theory of the factors found to affect the selection of non-traditional types of building project price forecasting models’.

As a result of this study a constraints-based theory of factors affecting the selection of non-traditional types of building project price forecasting models was advanced for the first time. The study found that the following factors were a feature of those large sized project management and large sized multi-disciplinary types of organisations, which were found to be more likely to select non-traditional types of building project price forecasting models, and as a result the following was advanced as an emergent grounded theory

‘An emergent grounded constraints-based theory of factors that affect the selection of non-traditional building project price forecasting models predicts that, as well as model understanding, forecasters who were situated in large sized project management and multi-disciplinary types of organisations and who,

select models on projects which have drawn and non-drawn data available, and who respond in urgent and non-urgent timescales to sophisticated and non-sophisticated clients on projects that were of a usual as well as non-usual in type,

and who

adopt a proactive approach to the provision of their building project price forecasting services, and consider accuracy to be more than just feedback on the accuracy of the model output, and which accept an extensive range of commissions

and who

have access to an extensive cost database which was support with networked cost information models based on stored electronic data, and have access to support facilities in terms of computers and staff expertise which could be drawn upon from across the organisation’s multi-sites, and who have an open, learning culture towards the development of new procedures,

would be more likely to be involved with the selection of non-traditional as well as traditional types of building project price forecasting models than those forecasters who were situated in small sized quantity surveying practices who did not match the properties indicated above’

10.2.2 Generally for practice

The wholesale transfer of technology into any business process requires time to achieve a co-maturation of technological resource availability and business organisation and approach. This work has shown that wholesale technology transfer, in terms of the processes involved in building project price forecasting has not yet taken place, despite the initial calls for change being made in 1982. The work has called into question whether certain types of business unit associated with the process of building project price forecasting preparation, namely small sized quantity surveying only practices, will ever reach a suitable stage of maturation. This work has questioned whether such organisations will continue to be able to provide a truly professional service to their clients if they are not able to fully embrace the transfer of technology into their business processes. This study has indicated that further work is required to establish the level of business maturation attained and the approach adopted to technology transfer by those medium sized business units involved in the process of building project price forecasting preparation.

10.3 Limitations of the study

The part-time nature of the study itself, which commenced in 1994, provided a limitation on the work. In a rapidly changing environment it is possible for a study of this nature to become dated. That danger was partly offset in this study by delaying the data collection phase of the work as late as possible. However, the majority of the literature reviewed was material available prior to 1996 and so there was a danger of more recent work not being considered. Such a danger was partly offset by ensuring that recent work was considered in terms of impact at the writing-up stage of the study, and so for instance work by Raftery (1998), Bowen and Edwards (1998), Lowe (1998), Fortune and Hinks (1998), and Aouad *et al* (1999) were duly considered.

Indeed the work by Bowen and Edwards (1998), which became available after the qualitative data collection phases of this study had been commenced, was found to be lightweight in its scope and findings in comparison with both the comprehensive number of model selection factors that were initially identified in this study, and the richer, deeper understanding of their complexity which emerged as a result of the rigorous qualitative data collection work incorporated into the later stages of this thesis. As a result the work of Bowen and Edwards (1998) merely confirmed the continued relevance of the topic area itself to other academics in the field and provided confirmation that some of the factors identified as affecting the selection of non-traditional building project price forecasting models in England were similar to some of the factors identified as affecting building project price forecasting model selection in Nigeria and South Africa.

The results of any quantitative investigation are limited by the nature of that approach. The execution of a full population survey of quantity surveying organisations that were operating in England in 1997 removed common concerns about sample size, generalisability, and the potential for biased results. However, survey results can always be affected by error and that remains a possibility in this study. However, the data handling and entry onto spreadsheets for analysis within the minitab10 data analysis package was undertaken by a paid assistant whose work was checked for its reliability.

A further limitation on the quantitative investigation carried out within the body of the thesis was the danger of unreliable responses, the potential for misinterpretation, and an inability to supply respondents answers with additional data. The analysed responses to the questionnaire show that widespread misinterpretation was not a problem in this study. The danger of uncertain respondent quality was combatted by ensuring all communications were addressed by name to the nominal head of the organisation contacted. The participant confirmation forms and the reply slips that were returned with the questionnaire forms themselves provided some re-assurance

that the measuring instruments were completed by the persons requested to do so, but clearly this was an issue that was beyond the complete control of the researcher.

The results of the survey show that the measuring instrument devised did not fully identify all the risk analysis, knowledge based, and value related models currently used by practitioners. This omission should be addressed in any future work on the topic. The incidence in use of certain models was small. The analysis of data drawn from small populations of respondents can become biased due to the exaggerated percentage differences being observed. The assessment of accuracy and value as tool was made by practitioners involved in the building project price forecasting model selection process. Any further work in the topic area should seek to establish results on a more objective basis that takes into account the assessments made by the forecast users as well as the forecast providers.

Qualitative types of investigation can be considered to be limited due the small number and biased nature of the interviewees selected for data collection. This danger was combatted by the adoption of a large participant selection frame from which rigorous checks on respondent identity, experience (in terms of types of models actually used), and organisational setting were made before any of the interviewees were approached for their co-operation. This was done to ensure that the interviewees selected for data collection were situated in a variety of settings and were as informative as possible. The results from the quantitative phase of the study indicated that the newer non-traditional types of building project price forecasting models were generally at such low levels of usage that it was decided to gather data from practitioners who confirmed that they understood and used at least three the non-traditional models and had selected them for use. As a result it was intended that data were to be gathered from committed practitioners which could potentially have been limiting.

However, it was found that the contextual information gathered on each of the potential interviewees via the participant confirmation forms, were in some cases incorrect. A number of interviewees when addressed in the face-to-face interview

situation revealed that they did not select or make any actual use of the newer non-traditional models, despite having previously indicated that they did. A more purposeful collection of data from the non-users of the non-traditional types of building project price forecasting models would further enrich the data already collected. A further limitation with the study was the nature of the qualitative data collected. The nation-wide survey indicated that the majority of organisations within the quantity surveying population of England was small in size. Inevitably access was directly negotiated with the organisations gatekeepers who were not all still involved in the building project price forecasting model selection process. A more balanced view of the model selection process from practitioners with operational as well as strategic responsibilities would have further enriched the data collected.

The constraints-based theory of factors affecting the selection of non-traditional building project price forecasting models emerged from the cross-case analysis of data gathered from interviewees 22-31. To an extent the data gathered had to go for breadth rather than depth as the number of practitioners actually involved with the selection of individual types of non-traditional models was found to be very small. The further grounding of the emergent constraints-based theory would need to consider factors affecting individual types of non-traditional model(s) in order to add more depth to the understanding of the model selection process already achieved. In addition the presently defined constraints-based theory operates at the poles of differing organisational types and sizes. A limitation of the emergent theory as presently defined is that it does not address the situation of medium sized organisations which wish to become more involved with the provision of non-traditional building project price advice and so become more involved with the selection of non-traditional types of models.

10.4 Recommendations for further work

The following recommendations for further work have been advanced following consideration of the conclusions to this study and its acknowledged limitations, and they include,

- * the 1997 nationwide survey together with the 1993 regional survey provide a base for further periodic data collection exercises, which in time, would allow trend based data to be generated which could gauge the extent of any general paradigm change in the process of formulating building project price advice.
- * although the level of model non-understanding was revealed to be a non-dominant factor that affected the selection of non-traditional building project price forecasting models, further work in the topic area would need to investigate the location of non-understanding in terms of grade of staff within the organisations not presently selecting the non-traditional models for use. Such further work would enable focused training and education programmes to be developed.
- * the general failure of the quantity surveying organisations in England to adopt the transfer of technology called for in the paradigm change in building project price forecasting approach, which has been consistently called for by academics since Brandon (1982), needs to be further investigated in order to establish the relevance of the called for paradigm change to the quantity surveying profession as a whole, and to the small and medium sized types of quantity surveying organisations in particular, that make-up the majority of such organisations within the population of quantity surveying organisations in England. Such a study would also establish the validity of the claims of such organisations to provide truly professional building project price forecasting services to their clients, as well as the relevance of the

research agenda on information technology transfer to the process of building project price forecasting.

- * the determination, as a result of this work, of the 'state of the art' in terms of the building project price forecasting models used by practitioners in England, provides a benchmark for further comparative studies on a global scale to establish a wider perspective on the selection, manipulation, and usefulness of different types of building project price forecasting models to involved construction professionals around the world.
- * The assessment of client requirements and their satisfaction levels with the building project price forecasting advice they receive in relation to the model selected as a tool by the practitioner concerned together with the tool selection factors identified as a result of the study would add to the emergent constraints-based theory and ensure that a richer, deeper understanding of the formulation phase of the building project price advice process was achieved. Such a complete picture would enhance the quality of the building project price advice provided to clients and as a consequence the quality of their business decisions
- * The emergent constraints-based theory of factors affecting the selection of non-traditional building project price forecasting models need to be further refined by collecting data from practitioners who were deselecting as well as selecting non-traditional models for use, and who had strategic as well as operational organisational responsibilities, and who were situated in medium sized organisations of differing types.
- * The selection factors embodied within the emergent constraints-based theory of building project price forecasting non-traditional model selection need to be weighted for their significance in terms of

particular individual model uptake, organisational constraints, and differing project circumstances. Such work would strengthen the relevance of the called for ‘applications-based’ school of research in building project price forecasting advice.

- * A ‘good practice guide’ or ‘decision support tool’ for building project price forecasting model selection needs to be developed in order to benchmark good practice across the profession and assist medium sized firms who wish to become more involved with the provision of non-traditional building project price advice and hence need to become involved in the selection of non-traditional types of models.

APPENDICES

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Liverpool John Moores University

School of the Built Environment

Date as postmark

Dear Sir / Madam

**EARLY COST ADVICE FOR CLIENTS
A NATIONAL STUDY INTO CURRENT PRACTICES**

I write to invite you to take part in a national survey concerned with current techniques used by quantity surveying organisations to provide early cost advice for clients.

A similar survey of building price forecasting techniques in use was carried out in 1993 with quantity surveying organisations based in the north of England. That survey attracted a very good response rate of 61%. The results of the 1993 survey have been summarised as feedback for you on the information sheet attached. More detailed results can be found in the March 1994 edition of Chartered Surveyor Monthly or in the research report entitled "The Relative Performance of New and Traditional Cost Models in Strategic Advice for Clients", published, with no financial benefit to the authors, by the RICS in April 1996.

This 1997 survey is part of a nationwide follow-on study into the above topic with all two thousand plus quantity surveying organisations based in England. It is being undertaken by staff based at Liverpool John Moores University and the University of Salford. Your response to this request for information will enable this study to establish all techniques currently in use, extend the geographic base of the survey and compare present performance ratings with those for the techniques that were in general use in 1993.

Your participation in this study will provide useful information that will help shape and form university teaching programmes in quantity surveying as well as information that will be of use to quantity surveying practitioners in general. In the future it is hoped that this research will allow the establishment of a forum for the development of building price forecasting skills to which your organisation will be invited to participate.

Once again it is planned to provide feedback to you both directly and indirectly through further mailings and articles in appropriate professional journals. All information received will be treated as confidential and will not be used or divulged in any way that would allow an individual organisation's details to be identified. Only those organisations and individuals that wish to take part in further research need identify themselves on the supplementary information sheet enclosed.

Please return your completed questionnaire and supplementary information sheet (if appropriate) in the freepost envelope provided as soon as possible.

Any queries about the survey or the questionnaire form should be addressed to the writer who can be contacted on 0151 231 3376.

Yours faithfully

A handwritten signature in cursive script, reading "Chris Fortune".

Chris Fortune
Course Leader Quantity Surveying

Director of School - Professor Peter H Morgan

How to get a copy of this letter: telephone 0151 231 2352 or e-mail 0151 2014994

EARLY ADVICE TO CLIENTS

A study into current practices

Notes for Guidance

- 1 Early advice is defined as any cost advice given to the client prior to a formal offer to contract being made.
- 2 Organisation is defined as the part of the company/practice (eg branch, office, department) for which you have responsibility.
- 3 Please indicate your response by circling the appropriate response in the shaded areas.

Question 1 - Type of organisation

Which of the following best describes your organisation's field of operation?

- | | |
|-----------------------------------|--------------------------------|
| 1 Quantity Surveying practice | 7 Management Contracting |
| 2 Multi-disciplinary practice | 8 Design and Build Contracting |
| 3 Architectural practice | 9 Specialist Contracting |
| 4 Consulting Engineering practice | 10 Project Management |
| 5 Local or Public Authority | 11 Civil Engineering |
| 6 General Contracting | 12 None of these |

Question 2 - Computing Facility

Within your organisation what is the ratio of staff to computer workstations?

- | | | | | |
|----------------------------|----------------------------|----------------------------|-------------------------------------|-------------------------|
| 1 1 staff to 1 workstation | 2 2 staff to 1 workstation | 3 3 staff to 1 workstation | 4 more than 3 staff per workstation | 5 no computing facility |
|----------------------------|----------------------------|----------------------------|-------------------------------------|-------------------------|

Question 3 - Early advice

Does your organisation give early advice to clients?

Yes / No

If the answer is No you do not need to respond to the remaining questions, please return the questionnaire and thank you for your cooperation

If the answer is Yes please continue with the questionnaire

Question 4 - Work distribution

a How many members of your staff are actively involved with early advice function?

Staff

b What proportion of the early advice function is undertaken at the following levels?

- | | |
|------------------|----------------|
| Partner/Director | C _P |
| Senior Surveyor | C _S |
| Surveyor | C _D |
| Trainee | C _T |

Question 5 - Early Advice Techniques

Appendices

The following questions relate to techniques for developing early advice to clients. If your response to 5a is Yes then continue with 5b to 5e, if No then continue with 5f and 5g.

	5a Has your organisation ever used the technique?	Yes to 5a (1 - least extent, 4 - most extent)				No to 5a	
		5b To what extent does the technique produce reliable and accurate information?	5c To what extent does the technique rely on the use of judgement?	5d To what extent is the technique a valuable tool?	5e Does your organisation currently use the technique?	5f Do you understand how the technique works?	5g Does your organisation have the capability to perform the technique?
Traditional Techniques							
Judgement - the use of experience and intuition without quantification	Yes / No	1 2 3 4	1 2 3 4	1 2 3 4	Yes / No	Yes / No	Yes / No
Functional unit - single rate applied to the amount of provision (eg £/pupil schools)	Yes / No	1 2 3 4	1 2 3 4	1 2 3 4	Yes / No	Yes / No	Yes / No
Cost per m2 - single rate applied to the gross floor area	Yes / No	1 2 3 4	1 2 3 4	1 2 3 4	Yes / No	Yes / No	Yes / No
Principal item - single rate applied to the principal item of work	Yes / No	1 2 3 4	1 2 3 4	1 2 3 4	Yes / No	Yes / No	Yes / No
Interpolation - interpolating the total cost from previous projects	Yes / No	1 2 3 4	1 2 3 4	1 2 3 4	Yes / No	Yes / No	Yes / No
Elemental analysis - the use of Element Unit Rates to build up an estimate	Yes / No	1 2 3 4	1 2 3 4	1 2 3 4	Yes / No	Yes / No	Yes / No
Significant items - measurement of significant items of work and priced individually	Yes / No	1 2 3 4	1 2 3 4	1 2 3 4	Yes / No	Yes / No	Yes / No
Approximate quantities - measurement of a small number of grouped items priced in groups	Yes / No	1 2 3 4	1 2 3 4	1 2 3 4	Yes / No	Yes / No	Yes / No
Detailed quantities - priced detailed quantities (eg BQ)	Yes / No	1 2 3 4	1 2 3 4	1 2 3 4	Yes / No	Yes / No	Yes / No

Question 5 contd - Early Advice Techniques

The following questions relate to techniques for developing early advice to clients. If your response to 5a is Yes then continue with 5b to 5e, if No then continue with 5f and 5g.

	5a Has your organisation ever used the technique?	Yes to 5a (1 - least extent, 4 - most extent)				No to 5a	
		5b To what extent does the technique produce reliable and accurate information ?	5c To what extent does the technique rely on the use of judgement?	5d To what extent is the technique a valuable tool?	5e Does your organisation currently use the technique?	5f Do you understand how the technique works?	5g Does your organisation have the capability to perform the technique?
Statistical Techniques							
Regression analysis - cost models derived from statistical analysis of variables	Yes / No	1 2 3 4	1 2 3 4	1 2 3 4	Yes / No	Yes / No	Yes / No
Time Series Models - based on statistical analysis of trends	Yes / No	1 2 3 4	1 2 3 4	1 2 3 4	Yes / No	Yes / No	Yes / No
Causal Cost Models - Models based on algebraic expression of physical dimensions	Yes / No	1 2 3 4	1 2 3 4	1 2 3 4	Yes / No	Yes / No	Yes / No
Knowledge Based Systems							
ELSIE - as marketed by Imaginix Systems	Yes / No	1 2 3 4	1 2 3 4	1 2 3 4	Yes / No	Yes / No	Yes / No
Other knowledge based systems - any other system	Yes / No	1 2 3 4	1 2 3 4	1 2 3 4	Yes / No	Yes / No	Yes / No
Life Cycle Costing techniques							
Net Present Value - discounting future costs to present values	Yes / No	1 2 3 4	1 2 3 4	1 2 3 4	Yes / No	Yes / No	Yes / No
Payback method - calculating the period over which an investment pays for itself	Yes / No	1 2 3 4	1 2 3 4	1 2 3 4	Yes / No	Yes / No	Yes / No
Discounted Cashflow - calculating the discounted rate of return	Yes / No	1 2 3 4	1 2 3 4	1 2 3 4	Yes / No	Yes / No	Yes / No

Question 5 contd - Early Advice Techniques

Appendices

The following questions relate to techniques for developing early advice to clients. If your response to 5a is Yes then continue with 5b to 5e, if No then continue with 5f and 5g.

	5a Has your organisation ever used the technique?	Yes to 5a (1 - least extent, 4 - most extent)				No to 5a	
		5b To what extent does the technique produce reliable and accurate information ?	5c To what extent does the technique rely on the use of judgement?	5d To what extent is the technique a valuable tool?	5e Does your organisation currently use the technique?	5f Do you understand how the technique works?	5g Does your organisation have the capability to perform the technique?
Resource/Process Based Techniques							
Resource based - the use of schedules of materials' plant and labour etc	Yes / No	1 2 3 4	1 2 3 4	1 2 3 4	Yes / No	Yes / No	Yes / No
Process based - The use of bar charts and networks	Yes / No	1 2 3 4	1 2 3 4	1 2 3 4	Yes / No	Yes / No	Yes / No
Construction Cost Simulator - a proprietary system	Yes / No	1 2 3 4	1 2 3 4	1 2 3 4	Yes / No	Yes / No	Yes / No
Risk Analysis techniques							
Monte Carlo Simulation - based on estimated price and chance deviation	Yes / No	1 2 3 4	1 2 3 4	1 2 3 4	Yes / No	Yes / No	Yes / No
Other risk analysis - any other form of risk analysis	Yes / No	1 2 3 4	1 2 3 4	1 2 3 4	Yes / No	Yes / No	Yes / No
Value Related techniques							
Value Management - the use of function appraisal in budget formulation	Yes / No	1 2 3 4	1 2 3 4	1 2 3 4	Yes / No	Yes / No	Yes / No
Other techniques - any other form of value related techniques	Yes / No	1 2 3 4	1 2 3 4	1 2 3 4	Yes / No	Yes / No	Yes / No

EARLY COST ADVICE FOR CLIENTS
A NATIONAL STUDY INTO CURRENT PRACTICES

SUPPLEMENTARY INFORMATION SHEET

- (1) The 1993 survey identified that some organisations were using early cost advice techniques that were not listed on the attached questionnaire. If your organisation has used or continues to use another knowledge based system, risk analysis or value related technique or some other technique(s) then please name the technique(s) in the space below,

.....
.....
.....

- (2) This 1997 survey is part of a continuing study into early cost advice techniques in use. If you and / or your organisation would wish to take part in further research into the criteria used for technique selection then please indicate below either your name and telephone number or the name and telephone number of the most appropriate person to contact within your organisation.

.....
.....
.....

**THANK YOU FOR YOUR TIME AND EFFORT IN RESPONDING TO
THIS REQUEST FOR INFORMATION**

Table 3.8 Summary of Responses to Questions 5 (a) to 5 (e)

Models	5(a) Has your organisation ever used the technique Yes		5(b) Mean value ratings for reliability and accuracy	5(c) Mean value rating for use of judgement	5(d) Mean value rating for valuable tool	5(e) Currently use the technique	
	Nr	%				Nr	%
Traditional							
Judgement	847	82.90	2.31	3.77	2.59	737	87.01
Functional unit	712	69.74	2.30	2.86	2.45	570	80.01
Cost per m ²	990	96.96	2.74	3.08	3.04	945	95.45
Principal item	404	39.57	2.33	3.09	2.35	299	74.01
Interpolation	859	84.13	2.71	3.11	2.76	757	88.13
Elemental analysis	899	88.05	3.17	2.79	3.19	829	92.21
Significant items	713	69.83	2.99	2.87	2.95	602	84.43
Approx quants	953	93.34	3.53	2.57	3.52	917	96.22
Detailed quants	650	63.36	3.81	2.14	3.49	592	91.08
Statistical							
Regression analysis	132	12.93	2.39	2.97	2.29	86	65.15
Time series models	119	11.66	2.23	2.98	2.26	69	57.98
Causal cost models	54	5.29	2.43	3.06	2.33	35	64.81
Knowledge Based							
ELSIE	158	15.48	2.59	2.83	2.62	91	57.59
Other KBS	137	13.42	2.83	2.73	2.89	110	80.29
Life Cycle Costing							
Net present value	548	53.67	2.53	2.92	2.55	397	72.44
Payback method	452	44.27	2.58	2.91	2.64	302	66.81
Discounted cash flow	449	43.98	2.57	2.85	2.56	306	68.15
Resource / Process							
Resource	472	46.23	2.89	2.83	2.59	312	66.10
Process	269	26.35	2.65	3.04	2.59	190	70.63
Construction Cost Sim	51	5.00	2.78	2.76	2.65	33	64.71
Risk Analysis							
Monte carlo sim	129	12.63	2.49	3.18	2.50	96	74.42
Other RA	238	23.31	2.53	3.31	2.63	199	83.61
Value Related							
Value management	333	32.62	2.75	3.18	2.81	253	75.98
Other	98	9.60	2.83	3.24	2.87	86	87.76

Table 3.9 Summary of Responses to Questions 5 (f) and 5 (g)

Models	5(f) Do you understand how the technique works ?		5(g) Does your organisation have the capability to perform the technique ?	
	Yes		Yes	
	Nr	% Not used & notu/std	Nr	% of non-users
Traditional				
Judgement	158	2.84	152	2.73
Functional unit	264	7.07	237	6.35
Cost per m ²	39	0	33	0
Principal item	388	19.33	374	18.63
Interpolation	139	12.80	127	11.69
Elemental analysis	114	7.26	99	6.30
Significant items	245	10.00	230	9.39
Approx quants	68	4.29	61	3.85
Detailed quants	308	1.34	290	1.26
Statistical				
Regression analysis	255	45.34	214	38.05
Time series models	235	41.59	194	34.33
Causal cost models	174	63.26	177	64.35
Knowledge Based				
1:1 SIE	312	34.22	123	13.49
Other KBS	185	41.88	98	22.19
Life Cycle Costing				
Net present value	325	17.89	252	13.87
Payback method	370	19.61	293	15.53
Discounted cash flow	345	23.86	283	19.57
Resource / Process				
Resource	321	29.95	252	23.51
Process	285	31.70	204	22.69
Construction Cost Sim	202	63.68	109	34.33
Risk Analysis				
Monte carlo sim	183	43.74	125	29.88
Other RA	145	42.68	104	30.61
Value Related				
Value management	215	27.97	156	21.27
Other	18	34.88	98	28.97

APPENDIX 4.1

Table 4.2 Crosstabulation of QS/Multi-Disciplinary/Proj Man Organisational Types and incidence in-use of models

Model % Difference act-exptd count	Q.S Practice	Multi-Disc Org	Proj Man Org	Statistical X ²	Indicators p>0.01	Cramers V
Traditional						
Judgem't	-3.76	10.99	16.05	17.48	0.001	0.13
Func	-5.15	12.82	24.28	20.75	0.001	0.14
Costm2	-1.81	6.54	7.37	12.51	0.002	0.11
Prin	-5.74	4.55	38.46	10.49	0.005	0.10
Inter	-2.73	6.45	13.25	11.33	0.004	0.11
Elem	-1.68	2.04	10.34	6.88	0.032	0.08
Sig Item	-3.04	8.86	12.86	7.04	0.030	0.08
App Q	-0.29	0.97	1.09	0.25	0.882	0.02
Det Q	-2.75	5.71	14.29	4.36	0.114	0.07
Statistical						
RegRes	-13.27	26.67	69.23	10.53	0.005	0.10
Time S	-14.61	46.15	50.00	8.63	0.014	0.09
Caus Co	-13.16	0.00	100.00	5.79	0.056	0.08
Knowledge						
ELSIE	-7.83	29.41	33.33	4.13	0.128	0.06
OthKBS	-17.48	33.33	80.00	20.17	0.001	0.14
Life Cycle						
NPV	-10.95	41.67	35.85	44.27	0.001	0.21
PayB	-9.88	24.00	47.73	27.46	0.001	0.16
DCF	-11.71	38.00	45.45	36.18	0.001	0.19
Res/Proc Based						
ResB	-6.12	19.61	23.91	10.70	0.005	0.10
ProcB	-21.03	37.93	115.38	63.37	0.001	0.25
Con Co S	-19.44	40.00	100.00	7.95	0.019	0.09
Risk Analysis						
Monte C	-18.56	57.14	76.92	17.39	0.001	0.13
Oth RA	-13.64	19.23	82.61	15.09	0.001	0.12
Value Related						
Val Man	-11.69	24.32	60.61	25.97	0.001	0.16
Other	-15.07	27.27	80.00	10.17	0.006	0.10
X ² 9.21 df 2	p=0.01 16 (S)	p=0.01 8 (NS)	p=0.05 20 (S)	p=0.05 4 (NS)		

APPENDIX 4.1

Table 4.3 Cross tabulations of computing facilities and model incidence in-use (quantity surveying type organisations only)

Ratio Staff to computer (% Difference act-exptd count)	1:1	2:1	3:1	>3:1	None	Statistical X ²	Indicator p=0.01	Cramer's V
Traditional								
Judgem't	-5.57	9.77	18.97	-3.57	-27.91	30.72	0.001	0.20
Func	-11.57	17.01	22.45	17.39	-33.33	39.49	0.001	0.22
Costm2	-5.81	6.25	11.43	12.12	-9.80	36.79	0.001	0.22
Prin	-11.76	26.50	-10.57	7.69	-20.00	14.41	0.006	0.14
Inter	-6.76	11.73	16.67	0.00	-25.00	35.57	0.001	0.22
Elem	-5.75	7.89	12.50	13.33	-21.28	31.68	0.001	0.20
Sig Item	-8.43	15.23	11.76	0.00	-21.62	22.49	0.001	0.17
App Q	-5.36	5.42	10.29	15.63	-8.00	25.08	0.001	0.18
Det Q	-5.83	4.44	22.22	-18.18	-18.18	12.25	0.016	0.13
Statistical								
RegRes	0.00	20.00	25.00	-25.00	-100.0	8.61	0.072	0.10
Time S	0.00	63.64	-62.50	-100.0	-100.0			
Caus Co	-6.25	50.00	0.00	-100.0	-100.0			
Knowledge								
FI SIF	-17.31	51.61	0.00	0.00	-100.0	19.73	0.001	0.16
OthKBS	2.44	24.00	37.50	-25.00	-100.0	9.69	0.047	0.11
Life Cycle								
NPV	-9.20	21.91	25.71	17.64	-73.08	41.76	0.001	0.23
PayB	-6.85	22.72	20.00	0.00	-72.72	28.63	0.001	0.19
DCI	0.00	13.95	24.14	7.14	-90.48	32.97	0.001	0.20
Res/Proc Based								
ResB	5.13	8.42	-15.63	-6.67	-43.48	10.90	0.028	0.12
ProcB	1.33	10.87	0.00	28.57	-63.64	7.08	0.133	0.09
Con Co S	0.00	33.33	-66.67	-100.0	0.00	4.14	0.388	0.07
Risk Analysis								
Monte C	7.89	34.78	37.50	0.00	-83.33	11.15	0.026	0.12
Oth RA	-18.92	46.67	20.00	14.29	-81.82	25.77	0.001	0.18
Value Related								
Val Man	-4.67	21.54	9.09	10.00	-81.25	19.61	0.001	0.16
Other	16.67	50.00	16.67	33.33	-75.00	8.87	0.45	0.11
X ² 9.21 d.f. 2	p=0.001 13 (S)	p>0.01 11 (NS)	p=0.005 22 (S)	p>0.05 2 (NS)				

APPENDIX 4.1

Table 4.4 Size of QS organisation and model incidence in-use
(showing statistical indicators)

Model	Size	Size	Size	Size	Statistical	Indicators	Cramers
% Difference act-exptd count	1	2 - 5	6 - 10	11+	X ²	p=0.01	V
Traditional							
Judgement	-14.86	4.26	12.00	0.00	25.36	0.001	0.20
Func Unit	-31.20	5.96	26.19	44.12	66.98	0.001	0.33
Cost/m2	-5.03	1.92	1.64	4.08	20.39	0.001	0.18
Prin Item	-30.43	0.00	52.17	52.63	27.87	0.001	0.21
Interpolation	-13.55	3.70	9.43	14.29	27.02	0.001	0.21
Elem Analysis	-15.85	5.94	7.14	11.11	51.99	0.001	0.29
Signif Items	-13.95	4.02	13.64	8.57	11.28	0.011	0.13
App Quants	-4.55	2.29	1.69	0.00	27.82	0.001	0.21
Det Quants	-10.34	0.00	17.95	18.75	6.72	0.082	0.10
Statistical							
Reg Analysis	-63.16	-42.42	116.67	400.00	105.94	0.001	0.41
Time Series	-55.56	-46.88	116.67	380.00	101.16	0.001	0.40
Caus Cost Model	-75.00	-28.57	66.67	350.00	30.85	0.001	0.22
Knowledge							
ELSIE	-64.00	-22.73	55.56	300.00	92.71	0.001	0.39
Oth KBS	-61.90	-2.70	57.14	166.67	32.31	0.001	0.23
Life Cycle							
NPV	-48.89	8.28	45.16	68.00	80.77	0.001	0.36
Payback Method	-45.45	5.22	57.69	66.67	57.85	0.001	0.30
DCF	-42.47	1.57	52.00	80.00	54.45	0.001	0.30
Res/Proc Based							
Res based	-2.41	-5.56	-3.57	43.48	9.41	0.025	0.13
Process based	-13.51	-10.77	7.69	110.00	16.27	0.001	0.16
Con Cost Model	-25.00	-35.71	100.00	200.00	13.35	0.004	0.15
Risk Analysis							
Monte Carlo	-77.78	-16.13	133.33	220.00	82.08	0.001	0.36
Oth Risk Anal	-64.86	-13.85	107.69	190.00	84.96	0.001	0.37
Value Related							
Val Mangem't	-61.82	-1.03	73.68	140.00	86.37	0.001	0.37
Oth Value Mgmt	-50.00	-18.52	100.00	200.00	25.07	0.001	0.20
df = 3, X ² 11.34	p > 0.001	4 (NS)	20 (S)				

APPENDIX 4.1

Table 4.5 Crosstabulation of computing facilities and incidence of building project price forecasting models in-use (showing statistical indicators)

Ratio Staff to computer (% Difference act-exptd count)	1:1	2:1	3:1	>3:1	None	Statistical X ²	Indicator p>0.01	Cramers V
Traditional								
Judgm't	-6.03	9.60	13.83	2.08	-28.30	40.96	0.001	0.19
Func	-11.04	16.19	17.72	15.00	-38.64	54.51	0.001	0.22
Costm2	-5.58	6.51	9.09	10.71	-14.75	52.27	0.001	0.22
Prin	-11.05	21.85	-2.22	13.04	-28.00	16.25	0.003	0.12
Inter	-7.43	54.55	15.79	8.16	-30.19	56.03	0.001	0.23
Elem	-5.67	7.92	13.13	7.84	-25.00	28.11	0.001	0.16
Sig Item	-9.82	16.11	11.39	0.00	-22.73	34.24	0.001	0.18
App Q	-5.13	7.12	7.62	5.56	-11.86	29.29	0.001	0.16
Det Q	-5.88	3.65	15.28	18.92	-17.50	13.84	0.008	0.12
Statistical								
RegRes	0.00	17.95	20.00	-28.57	-100.0	12.61	0.014	0.11
Time S	-5.36	54.29	46.15	-57.14	-85.71	23.37	0.001	0.15
Caus Co	-4.00	20.00	0.00	33.33	-100.0	4.26	0.372	0.06
Knowledge								
FI SH	17.81	47.83	17.65	-22.22	-100.0	27.29	0.001	0.16
Oth KBS	-6.15	29.27	20.00	-37.50	-100.0	16.03	0.003	0.12
Life Cycle								
NPV	8.17	18.01	21.31	12.90	-73.53	56.49	0.001	0.23
PayB	-7.08	22.56	14.00	3.85	-78.57	43.97	0.001	0.20
DCI	-2.37	15.91	16.00	8.00	-92.86	48.35	0.001	0.21
Rev/Proc Based								
ResB	-1.80	13.67	7.69	-14.81	-51.72	19.78	0.001	0.13
ProcB	-1.57	29.73	-6.67	0.00	-70.59	15.51	0.04	0.12
Con C'o S	-4.17	46.67	-66.67	-66.67	-33.33	7.72	0.103	0.08
Risk Analysis								
Monte C	-9.84	33.33	28.57	-71.43	-87.50	18.82	0.001	0.13
Oth RA	-12.50	35.71	19.23	-21.43	-86.67	29.01	0.001	0.16
Value Related								
Val Man	-5.73	24.49	8.11	-5.26	-85.71	30.91	0.001	0.17
Other	10.87	41.38	0.00	-20.00	-83.33	11.24	0.025	0.10
X ² 9.21 df 2	p 0.01 19 (S)	p 0.01 5 (NS)	p 0.05 22 (S)	p 0.05 2 (NS)				

APPENDIX 4.1

Table 4.6 Cross tabulation of size of organisation and model incidence in-use (o/all) (showing statistical indicators)

Model	Size	Size	Size	Size	Statistical	Indicators	Cramers
% Difference act-exptd count	1	2 - 5	6 - 10	11+	X ²	p>0.01	V
Traditional							
Judgement	-14.59	3.05	8.73	7.59	32.83	0.001	0.19
Func Unit	-30.77	0.72	21.70	34.85	98.78	0.001	0.34
Cost/m2	-5.96	1.55	3.38	2.15	33.02	0.001	0.19
Prin Item	-27.27	0.00	11.67	42.11	24.33	0.001	0.17
Interpolation	-13.16	3.27	6.98	6.17	29.32	0.001	0.18
Elem Analysis	-15.08	2.56	8.89	9.41	55.94	0.001	0.25
Signif Items	-15.38	2.17	8.49	12.12	17.89	0.001	0.14
App Quants	-5.24	1.34	4.93	1.12	14.07	0.001	0.13
Det Quants	-15.28	-0.78	14.29	16.39	19.62	0.001	0.15
Statistical							
Reg Analysis	-73.08	-32.61	1.18	254.55	103.52	0.001	0.34
Time Series	-65.38	-21.74	35.29	190.91	62.18	0.001	0.27
Caus Cost Model	-81.82	-5.00	0.00	180.00	27.11	0.001	0.18
Knowledge							
ELSIE	-69.70	-18.97	36.86	185.71	81.25	0.001	0.30
Oth KBS	-73.33	-9.62	55.00	123.08	50.22	0.001	0.24
Life Cycle							
NPV	-49.58	2.84	30.86	54.90	113.01	0.001	0.36
Payback Method	-43.43	1.70	32.84	45.24	61.32	0.001	0.26
DCF	-45.36	0.58	31.82	53.66	67.30	0.001	0.28
Res/Proc Based							
Res based	-7.62	-4.30	2.82	33.33	11.77	0.008 *	0.12
Process based	-22.41	-3.92	2.56	60.00	17.17	0.001	0.14
Con Cost Model	-18.18	-10.00	0.00	80.00	4.56	0.207 *	0.07
Risk Analysis							
Monte Carlo	-80.77	-36.96	83.33	209.09	95.14	0.001	0.33
Oth Risk Anal	-64.71	-23.33	70.59	131.82	106.50	0.001	0.35
Value Related							
Val Mangem't	-58.90	-3.88	40.00	90.32	87.64	0.001	0.32
Oth Value Mgmt	-42.86	-37.84	100.00	111.11	37.20	0.001	0.21
df = 3 N = 1134	p = .01	1 (NS)	23 (S)				

APPENDIX 4.1

Table 4. 7 Model incidence in-use 1997 South, 1997 North, and 1993 North

Model	1997 All Nr	1997 Nrth Nr	1993 Nrth Nr	1997 Sth (% Diff A-E)	1997 Nrth (% Diff A-E)	Chi- Sq 1997 S-N p=0.01	1997 Nrth (% Diff A-E)	1993 Nrth (% Diff A-E)	Chi Sq 1997/ 1993 Nrth
Traditional									
Judgement	847	270	291	1.2	-2.6	0.340	-16.3	14.8	0.000
Func Unit	712	219	253	2.8	-6.4	0.084	-17.8	41.5	0.000
Cost/m2	990	323	319	0.3	-0.3	0.865	-9.6	9.7	0.000
Prin Item	404	123	156	3.2	-7.3	0.226	-25.2	19.2	0.000
Interpolation	859	276	294	0.9	-1.4	0.530	-13.7	12.9	0.000
Elem Analysis	899	297	299	-0.3	1.0	0.715	-9.4	9.4	0.000
Signif Items	713	217	243	3.4	-7.3	0.049	-16.1	14.4	0.000
App Quants	953	316	325	-0.6	1.3	0.056	-10.4	10.2	0.000
Det Quants	650	220	228			0.339	-11.8	11.4	0.000
Statistical									
Reg Analysis	132	38	36	-1.6	3.6	0.310	-5.3	5.5	0.599
Time Series	119	33	49	5.3	-13.2	0.223	-6.1	16.3	0.007
CausCost Mod	54	18	25	6.9	-18.2	0.921	-33.3	24.0	0.080
Knowledge									
ELSIH	158	63	53	0.0	0.0	0.039	0.0	0.0	0.986
Oth KBS	137	50	41	-11.6	17.4	0.317	0.0	0.0	0.908
Life Cycle									
NPV	548	167	136	-5.7	12.0	0.139	-3.6	4.4	0.381
Payback Meth	452	143	125	3.4	-2.1	0.551	-2.1	2.4	0.629
DCF	449	139	111	1.6	-2.8	0.321	2.1	-2.7	0.656
Res/Proc Base									
Res based	472	146	171	2.6	-5.4	0.302	-17.8	15.2	0.000
Process based	269	85	107	2.5	-5.5	0.660	-23.5	18.7	0.000
ConCost Model	51	15	18	1.6	-2.4	0.608	-20.0	16.6	0.272
Risk Analysis									
Monte Carlo	129	39	19	5.6	-13.3	0.526	17.0	-31.6	0.040
Oth Risk Anal	238	72	57	4.4	-7.6	0.373	1.4	-1.8	0.790
Value Related									
Val Mangem't	333	107	78	3.6	-9.7	0.801	5.6	-7.7	0.270
OthVal Mgemt	98	30	28	0.9	-1.9	0.664	6.7	7.7	0.570

*NODES.TXT PAGE: 1 2/02/99 10:22:10

Q.S.R. NUD.1ST POWER VERSION, REVISION 4.0.
LICENSEE:CJF

PROJECT: PHA, INTERVIEWS 1- 4 BASED ON CRITERIA 1-28 FROM LITERATURE

```
(1)      /(A) USERS ENVIRONMENT
(1 1)    /(A) USERS ENVIRONMENT/DESIGN DATA (1)
(1 2)    /(A) USERS ENVIRONMENT/TIMESCALE (4)
(1 3)    /(A) USERS ENVIRONMENT/TYPE (5)
(1 4)    /(A) USERS ENVIRONMENT/PURPOSE (13)
(1 5)    /(A) USERS ENVIRONMENT/NATURE (13)

(2)      /(B) PREPARER
(2 1)    /(B) PREPARER/USE OF DATA (1)
(2 2)    /(B) PREPARER/MODEL (2)
(2 3)    /(B) PREPARER/UNDERSTANDING (3)
(2 4)    /(B) PREPARER/TYPE (5)
(2 5)    /(B) PREPARER/ACCURACY (6)
(2 6)    /(B) PREPARER/EXPERIENCE (7)
(2 7)    /(B) PREPARER/JUDGEMENT (8)
(2 8)    /(B) PREPARER/EASE OF INTERPRETATION (9)
(2 9)    /(B) PREPARER/RISK (10)
(2 10)   /(B) PREPARER/APPLICATION (11)
(2 11)   /(B) PREPARER/RELATIONS (26)

(3)      /(C) ORGANISATION
(3 1)    /(C) ORGANISATION/COST DATA (1)
(3 2)    /(C) ORGANISATION/FEEDBACK (12)
(3 3)    /(C) ORGANISATION/LABOUR RESOURCES (15)
(3 4)    /(C) ORGANISATION/AWARENESS (17)
(3 5)    /(C) ORGANISATION/COMPUTERS (25)
(3 6)    /(C) ORGANISATION/STRUCTURE (26)

(4)      /(D) MODEL
(4 1)    /(D) MODEL /DATA FOR MODEL (2)
(4 2)    /(D) MODEL /TIMESCALE (4)
(4 3)    /(D) MODEL /ACCURACY (6)
(4 4)    /(D) MODEL /APPLICATION (11)
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(4 6)    /(D) MODEL /FLEXIBILITY (18)
(4 7)    /(D) MODEL /COST (22)

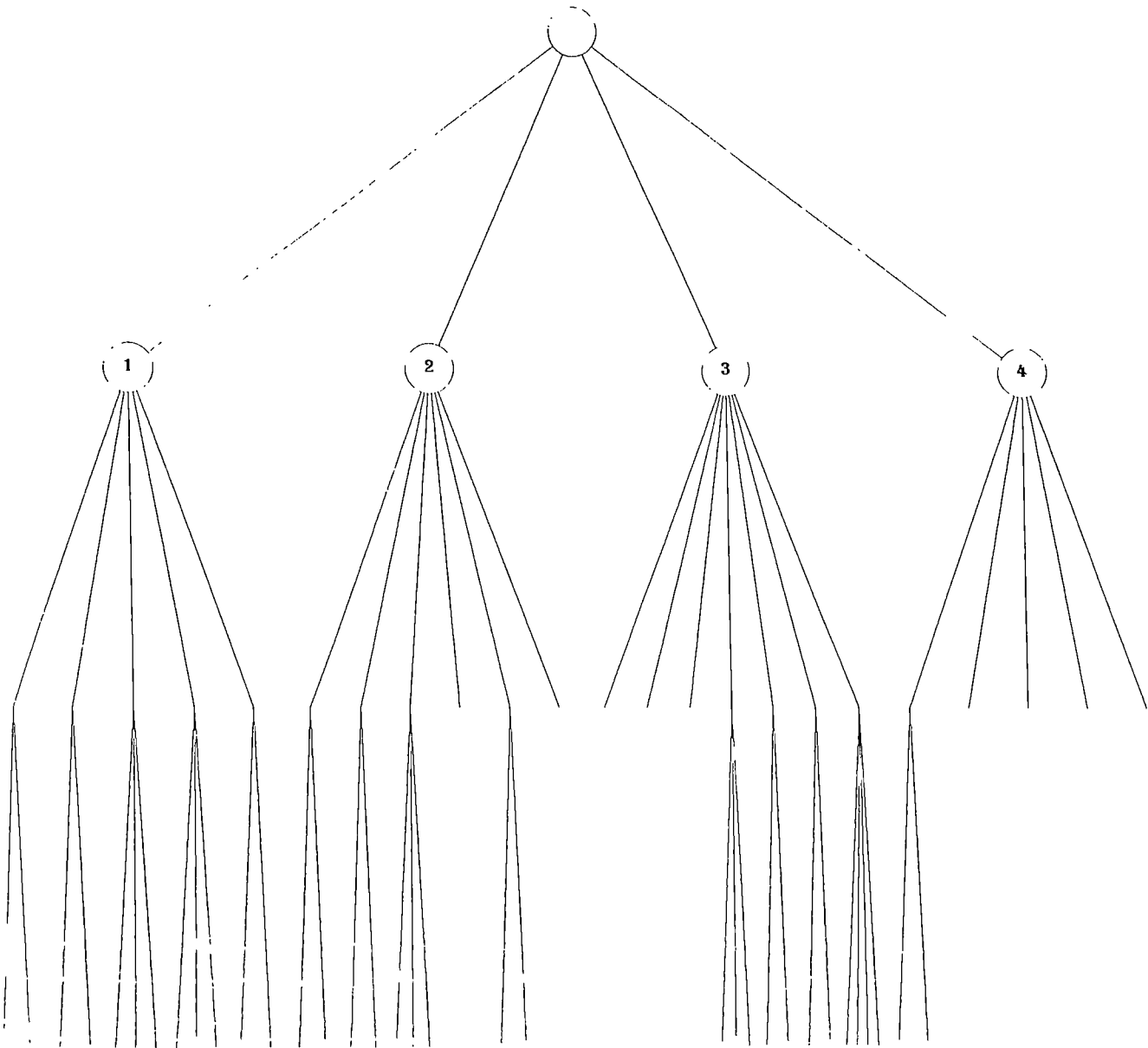
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(5 4)    /PROJECT CHARAS/QUALITY OF SPEC (24)
(5 5)    /PROJECT CHARAS/SHAPE (27)
(5 6)    /PROJECT CHARAS/LOCATION (28)

(D)      //DOCUMENT ANNOTATIONS
(F)      //FREE NODES
(T)      //TEXT SEARCHES
(I)      //INDEX SEARCHES
(C)      //NODE CLIPBOARD - 'NODE CLIPBOARD'
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NODES.TXT PAGE: 2 3/08/99 10:30:24

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(4 1) /TOOL APPLICABILITY/MODEL TYPE
(4 1 1) /TOOL APPLICABILITY/MODEL TYPE/TRADITIONAL
(4 1 2) /TOOL APPLICABILITY/MODEL TYPE/NEWER MODEL TYPES
(4 2) /TOOL APPLICABILITY/MODEL DATA
(4 3) /TOOL APPLICABILITY/OPERATIONAL CHARAS
(4 4) /TOOL APPLICABILITY/OUTPUT ACCURACY
(4 5) /TOOL APPLICABILITY/COSTS
(D) //DOCUMENT ANNOTATIONS
(F) //FREE NODES
(T) //TEXT SEARCHES
(T 1) //TEXT SEARCHES/TEXTSEARCH
(T 2) //TEXT SEARCHES/TEXTSEARCH193
(T 3) //TEXT SEARCHES/TEXTSEARCH195
(T 4) //TEXT SEARCHES/TEXTSEARCH196
(T 5) //TEXT SEARCHES/TEXTSEARCH204
(T 6) //TEXT SEARCHES/TEXTSEARCH205
(T 7) //TEXT SEARCHES/TEXTSEARCH206
(T 8) //TEXT SEARCHES/TEXTSEARCH207
(I) //INDEX SEARCHES
(I 1) //INDEX SEARCHES/INDEX SEARCH
(I 2) //INDEX SEARCHES/INDEX SEARCH194
(I 3) //INDEX SEARCHES/INDEX SEARCH197
(I 4) //INDEX SEARCHES/INDEX SEARCH198
(I 5) //INDEX SEARCHES/INDEX SEARCH199
(I 6) //INDEX SEARCHES/INDEX SEARCH193
(I 7) //INDEX SEARCHES/INDEX SEARCH195
(I 8) //INDEX SEARCHES/INDEX SEARCH196
(I 9) //INDEX SEARCHES/INDEX SEARCH200
MATRIX NODE.
(I 10) //INDEX SEARCHES/INDEX SEARCH201
(I 11) //INDEX SEARCHES/INDEX SEARCH202
(I 12) //INDEX SEARCHES/INDEX SEARCH203
(C) //NODE CLIPBOARD - TEXTSEARCH207
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TREE DISPLAY AT <ROOT> 3/08/99 10:33:37



NODES.TXT PAGE: 1 3/08/99 10:30:24

Q.S.R. NUD.IST POWER VERSION, REVISION 4.0.
LICENSEE: M HALL.

PROJECT: PHB, USER CHRIS F, 10:29 AM, MAR 8, 1999.

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(1)      /PROJECT AWARENESS
(1 1)    /PROJECT AWARENESS/PROJECT DATA
(1 1 1)  /PROJECT AWARENESS/PROJECT DATA/INFORMATION LEVELS
(1 1 2)  /PROJECT AWARENESS/PROJECT DATA/INFORMATION TYPE
(1 2)    /PROJECT AWARENESS/TIMESCALE
(1 2 1)  /PROJECT AWARENESS/TIMESCALE/HOURS
(1 2 2)  /PROJECT AWARENESS/TIMESCALE/DAYS, WEEKS
(1 3)    /PROJECT AWARENESS/PROJECT TYPE
(1 3 1)  /PROJECT AWARENESS/PROJECT TYPE/NATURE
(1 3 2)  /PROJECT AWARENESS/PROJECT TYPE/PHYSICAL CHARAS
(1 3 3)  /PROJECT AWARENESS/PROJECT TYPE/PROCUREMENT TYPE
(1 4)    /PROJECT AWARENESS/CLIENT TYPE
(1 4 1)  /PROJECT AWARENESS/CLIENT TYPE/ACCOUNTABILITY
(1 4 2)  /PROJECT AWARENESS/CLIENT TYPE/EDUCATION
(1 4 3)  /PROJECT AWARENESS/CLIENT TYPE/COMMISSIONING
(1 5)    /PROJECT AWARENESS/CLIENT DEMAND
(1 5 1)  /PROJECT AWARENESS/CLIENT DEMAND/MODEL TYPE
(1 5 2)  /PROJECT AWARENESS/CLIENT DEMAND/PURPOSE OF FORECAST
(2)      /DATA EVALUATION
(2 1)    /DATA EVALUATION/STYLE
(2 1 1)  /DATA EVALUATION/STYLE/STRATEGIC
(2 1 2)  /DATA EVALUATION/STYLE/NONSTRATEGIC
(2 2)    /DATA EVALUATION/ACCURACY
(2 2 1)  /DATA EVALUATION/ACCURACY/TARGET LEVELS
(2 2 2)  /DATA EVALUATION/ACCURACY/TIMING
(2 3)    /DATA EVALUATION/EXPERIENCE
(2 3 1)  /DATA EVALUATION/EXPERIENCE/OSITIVE
(2 3 2)  /DATA EVALUATION/EXPERIENCE/NEGATIVE
(2 3 3)  /DATA EVALUATION/EXPERIENCE/EASE OF APPLICATION
(2 4)    /DATA EVALUATION/JUDGEMENT
(2 5)    /DATA EVALUATION/RISK
(2 5 1)  /DATA EVALUATION/RISK/LEVELS
(2 5 2)  /DATA EVALUATION/RISK/MARKET CONDITIONS
(2 6)    /DATA EVALUATION/STAFF RELATIONS
(3)      /RESOURCE ASSSSMENT
(3 1)    /RESOURCE ASSSSMENT/COST DATABASE
(3 2)    /RESOURCE ASSSSMENT/FEEDBACK
(3 3)    /RESOURCE ASSSSMENT/STAFF EQUIPMT
(3 4)    /RESOURCE ASSSSMENT/APPROACH
(3 4 1)  /RESOURCE ASSSSMENT/APPROACH/CHANGE
(3 4 2)  /RESOURCE ASSSSMENT/APPROACH/AWARENESS
(3 4 3)  /RESOURCE ASSSSMENT/APPROACH/MARKETING STRATEGY
(3 5)    /RESOURCE ASSSSMENT/STRUCTURE
(3 5 1)  /RESOURCE ASSSSMENT/STRUCTURE/SINGLE SITE
(3 5 2)  /RESOURCE ASSSSMENT/STRUCTURE/MULTI SITE
(3 6)    /RESOURCE ASSSSMENT/TYPE
(3 6 1)  /RESOURCE ASSSSMENT/TYPE/QSP
(3 6 2)  /RESOURCE ASSSSMENT/TYPE/NONQSP
(3 7)    /RESOURCE ASSSSMENT/SIZE
(3 7 1)  /RESOURCE ASSSSMENT/SIZE/ONE
(3 7 2)  /RESOURCE ASSSSMENT/SIZE/SMALL
(3 7 3)  /RESOURCE ASSSSMENT/SIZE/MEDIUM
(3 7 4)  /RESOURCE ASSSSMENT/SIZE/LARGE
(4)      /TOOL APPLICABILITY
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Nodes.txt

page: 1

3/21/99 19:21:51

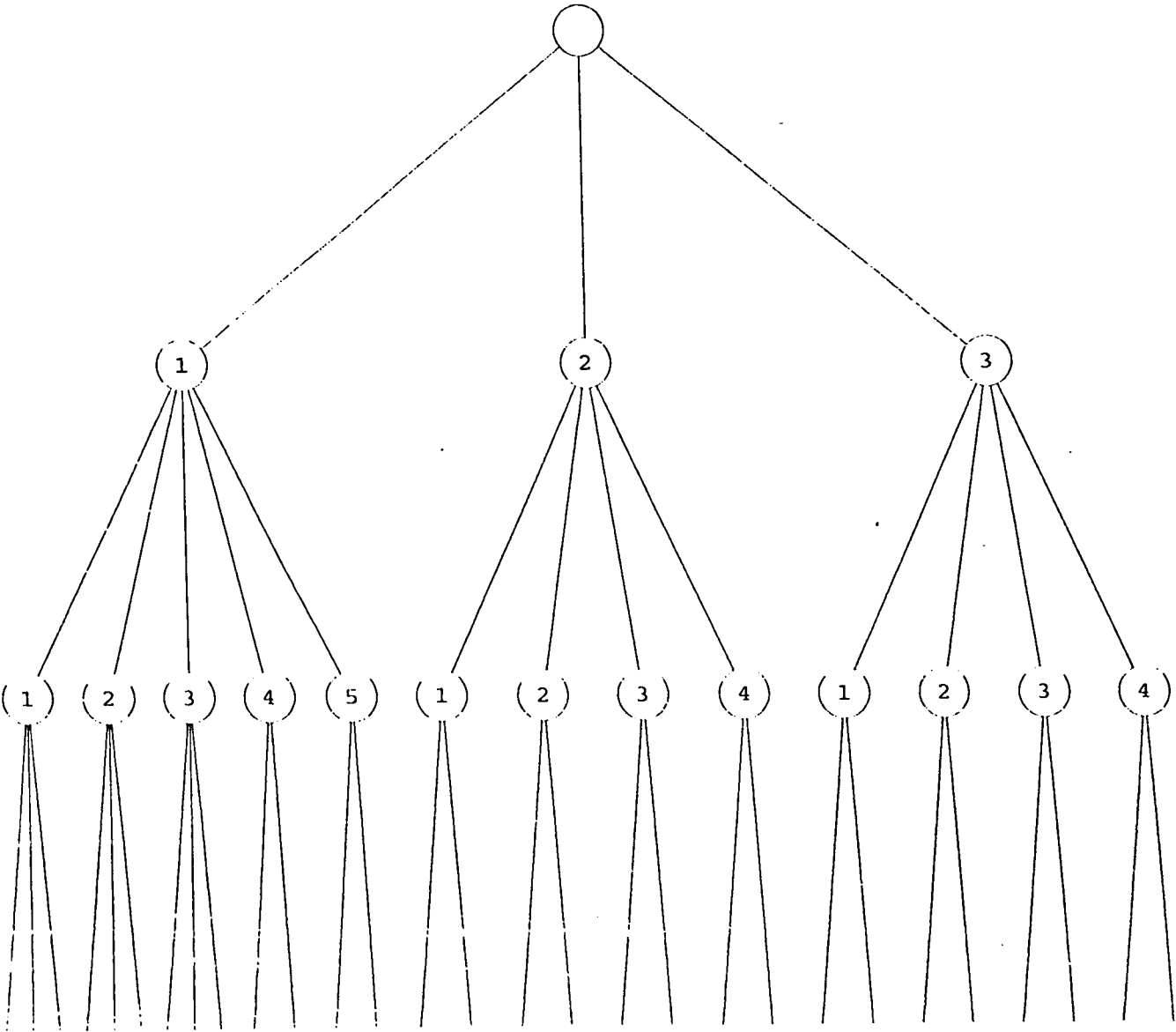
Q.S.R. NUD.IST Power version, revision 4.0.
Licensee: mark hall.

PROJECT: phab, User chris f, 7:21 pm, Mar 21, 1999.

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(1) /project awareness
(1 1) /project awareness/data
(1 1 1) /project awareness/data/verbal
(1 1 2) /project awareness/data/written
(1 1 3) /project awareness/data/drawn
(1 2) /project awareness/time
(1 2 1) /project awareness/time/urgent
(1 2 2) /project awareness/time/non urgent
(1 2 3) /project awareness/time/timing
(1 3) /project awareness/type
(1 3 1) /project awareness/type/nature
(1 3 2) /project awareness/type/status
(1 3 3) /project awareness/type/procurement
(1 4) /project awareness/client
(1 4 1) /project awareness/client/status
(1 4 2) /project awareness/client/sophistication
(1 5) /project awareness/service
(1 5 1) /project awareness/service/model
(1 5 2) /project awareness/service/context
(2) /response evaluation
(2 1) /response evaluation/approach
(2 1 1) /response evaluation/approach/proactive
(2 1 2) /response evaluation/approach/reactive
(2 2) /response evaluation/accuracy
(2 2 1) /response evaluation/accuracy/project parameters
(2 2 2) /response evaluation/accuracy/forecast parameters
(2 3) /response evaluation/feedback
(2 3 1) /response evaluation/feedback/model output
(2 3 2) /response evaluation/feedback/model application
(2 4) /response evaluation/commission
(2 4 1) /response evaluation/commission/fee
(2 4 2) /response evaluation/commission/risk
(3) /resource assessment
(3 1) /resource assessment/cost database
(3 1 1) /resource assessment/cost database/extensive
(3 1 2) /resource assessment/cost database/limited
(3 2) /resource assessment/support facilities
(3 2 1) /resource assessment/support facilities/computers
(3 2 2) /resource assessment/support facilities/structure
(3 3) /resource assessment/culture
(3 3 1) /resource assessment/culture/personal
(3 3 2) /resource assessment/culture/organisation
(3 4) /resource assessment/models
(3 4 1) /resource assessment/models/traditional
(3 4 2) /resource assessment/models/non traditional
(D) //Document Annotations
(F) //Free Nodes
(T) //Text Searches
(I) //Index Searches
(C) //Node Clipboard - 'Node Clipboard'
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Tree Display at <Root>

3/21/99 19:20:43



Nodes.txt

page: 1

3/22/99 08:09:20

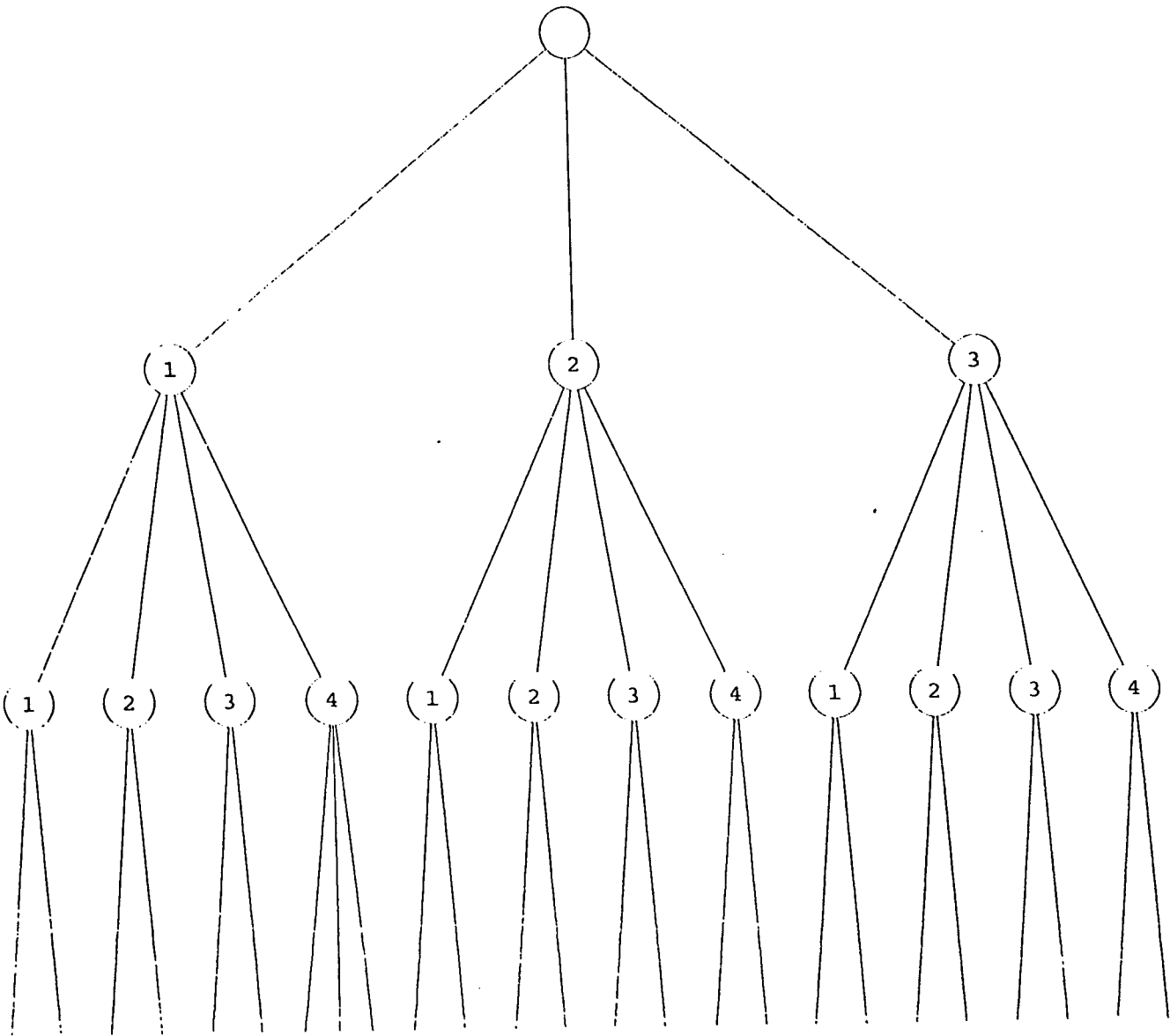
Q.S.R. NUD.IST Power version, revision 4.0.
Licensee: mark hall.

PROJECT: phab, User chris f, 8:09 am, Mar 22, 1999.

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(1) /project awareness
(1 1) /project awareness/data
(1 1 1) /project awareness/data/non-drawn info
(1 1 2) /project awareness/data/drawn info
(1 2) /project awareness/time
(1 2 1) /project awareness/time/urgent
(1 2 2) /project awareness/time/non urgent
(1 3) /project awareness/type
(1 3 1) /project awareness/type/features
(1 3 2) /project awareness/type/status
(1 4) /project awareness/client
(1 4 1) /project awareness/client/awareness
(1 4 2) /project awareness/client/model
(1 4 3) /project awareness/client/context
(2) /response evaluation
(2 1) /response evaluation/approach
(2 1 1) /response evaluation/approach/proactive
(2 1 2) /response evaluation/approach/reactive
(2 2) /response evaluation/accuracy
(2 2 1) /response evaluation/accuracy/project parameters
(2 2 2) /response evaluation/accuracy/forecast parameters
(2 3) /response evaluation/feedback
(2 3 1) /response evaluation/feedback/model output
(2 3 2) /response evaluation/feedback/model application
(2 4) /response evaluation/commission
(2 4 1) /response evaluation/commission/fee
(2 4 2) /response evaluation/commission/risk
(3) /resource assessment
(3 1) /resource assessment/cost database
(3 1 1) /resource assessment/cost database/extensive
(3 1 2) /resource assessment/cost database/limited
(3 2) /resource assessment/support facilities
(3 2 1) /resource assessment/support facilities/computers
(3 2 2) /resource assessment/support facilities/structure
(3 3) /resource assessment/culture
(3 3 1) /resource assessment/culture/personal
(3 3 2) /resource assessment/culture/organisation
(3 4) /resource assessment/models
(3 4 1) /resource assessment/models/traditional
(3 4 2) /resource assessment/models/non traditional
(D) //Document Annotations
(F) //Free Nodes
(T) //Text Searches
(I) //Index Searches
(C) //Node Clipboard - 'verbal'
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Tree Display at <Root>

3/22/99 08:08:12



Nodes.txt page: 1 3/30/99 21:56:28

Q.S.R. NUD.IST Power version, revision 4.0.
Licensee: mark hall.

PROJECT: ph4, User chris f, 9:01 pm, Mar 30, 1999.

```
(1) /project awareness
(1 1) /project awareness/data
(1 2) /project awareness/timescale
(1 3) /project awareness/project type
(1 4) /project awareness/client
(2) /response evaluation
(2 1) /response evaluation/approach
(2 2) /response evaluation/Accuracy
(2 3) /response evaluation/Commission
(3) /resource assessment
(3 1) /resource assessment/cost database
(3 2) /resource assessment/support facilities
(3 3) /resource assessment/culture
(D) //Document Annotations
(F) //Free Nodes
(T) //Text Searches
(I) //Index Searches
(C) //Node Clipboard - 'Node Clipboard'
```